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Trade in value added: do we need new measures of competitiveness?

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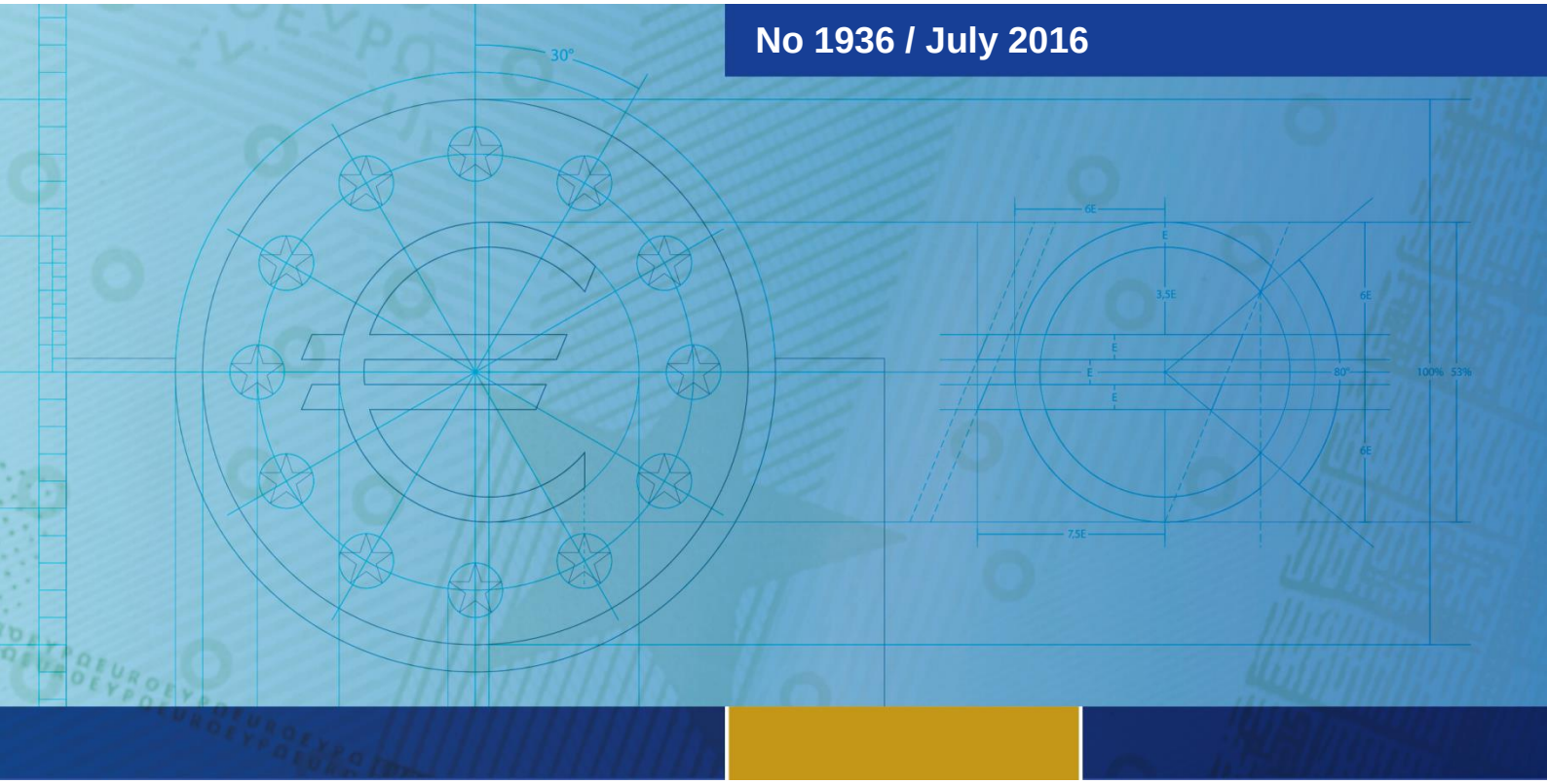


Abstract

It has been argued that the increasing importance of global value chains necessitates a modification of conventional competitiveness measures. We compile a broad dataset including value added trade, gross exports and conventional and value added based real exchange rates. To sharply focus on external competitiveness, a new price competitiveness indicator is introduced, the TWULC (Trade Weighted Unit Labour Cost indicator). It weights sector-specific cost trends according to sector shares in exports. Econometric tests for a panel of 38 countries show that the focus on value added trade generally improves the explanatory power of export equations. Value added exports' sensitivity towards real exchange rates is up to four times higher than that of gross exports. Real effective exchange rates focusing on exporting industries and on value added weights yield more robust results across the specifications, but do not systematically outperform the more conventional measures of price of cost competitiveness.

Key words: competitiveness, external trade, labour costs

JEL-codes: F14, J30

NON-TECHNICAL SUMMARY:

Recent literature has often found a low explanatory power of price or cost indicators for the export performance. This has intensified the interest in the impact of relative prices on the aggregate export performance. Two major hypotheses have been put forward in this respect: first, for export competitiveness, it is the prices of the actually traded goods that matter. Second, due to the increasing importance of value added trade, gross trade flows (potentially determined by cross-border production chains) are increasingly unrelated to traditional competitiveness measures. External competitiveness thus needs to be measured by new indicators, related to value added trade. Both hypotheses are empirically tested in our investigation.

There is a parallel discussion about which specific price and cost indicators (e.g. consumer prices, export prices, unit labour costs) are the most relevant for assessing an economy's competitiveness. Several papers propagate specific measures on theoretical grounds, without, however, providing a thorough empirical proof of their superiority. The small set of studies that empirically investigate the link between prices/costs and exports within export equations usually fail to show the dominance of one specific indicator.

This study adds to this literature in three ways. First, we introduce a new cost measure, the Trade Weighted Unit Labour Cost indicator (TWULC), which explicitly focuses on the sectors that actually export. Competitiveness can thus be specifically defined in terms of the export-oriented sectors. The basic intuition goes back to Gächter et al. (2013). Instead of (implicitly) weighting sectors according to their share in total value added, as conventional aggregate measures do, the TWULC re-weights sectoral ULC data according to sector shares in exports. Sectors that play a more important role in the export portfolio of a country thus get higher weights. The TWULC can therefore be assumed to better reflect the external cost competitiveness of the country. The concept of trade-weighting is also applied to deflators (TWDEFL).

The TWULC is then used to calculate the real effective exchange rate (REER), a measure of competitiveness that reflects both exchange rate movements and prices or cost developments relative to the most important trading partners. For this purpose, the bilateral real exchange rates for each partner country are weighted with the respective trade weight so that more important trading partners get higher weights.

Second, we account for the increasing importance of global value chains (GVCs) by basing the calculation of the REER measures not only on gross export data but alternatively also on value added export data that reflect the domestic contribution to exported goods. This goes

back to Bems and Johnson (2012) who suggested that the adequate measure of price competitiveness is the value added real effective exchange rate. The main data source for our computations is WIOD (World-Input-Output Database, Timmer, 2012; Timmer et al., 2015). From that database, we derive value added trade in current prices. The current-price value added exports from the WIOD were deflated with the TWDEFL, the trade-weighted deflators, in which the sectoral deflators are weighted according to their share in value added exports.

Third, we econometrically test the sensitivity of exports, in gross and value added terms, to relative prices within standard export equations: Exports are explained by according external demand as well as by changes in relative prices. To identify whether the newly developed REER is better able to explain export performance, we computed a whole range of alternative REERs, including the standard ones based on the CPI and aggregate GDP deflators but also aggregate unit labour costs and (gross) export prices. The econometric tests are performed on a panel of 38 countries. These include advanced and emerging economies.

Our results show that the focus on value added trade generally improves the explanatory power of the export equations as compared to traditional gross export equations. Value added exports' sensitivity towards REERs is up to four times higher than that of gross exports. This effect is even higher for the emerging market economies and the Eastern ("new") EU member states, probably the main targets of outsourcing of individual production stages.

We conclude that cost and price competitiveness importantly impacts trade outcomes, especially when measured through the domestic value added in exported products. The focus on exporting industries (TWULC) and on value added weights in real effective exchange rates yields more robust results across the specifications. Our new measure, the TWULC, should thus be integral part of the standard set of price and cost competitiveness measures. Overall, however, the newly developed real effective exchange rates cannot systematically outperform the more conventional measures of price of cost competitiveness. As a result, some conventional real effective exchange rate measures can be suitable for assessing export competitiveness also when it comes to value added trade. It is probably not so important to adjust competitiveness measures, but to give more attention to the measurement and use of value added in trade.

1. Introduction

How sensitive are exports to relative prices and labour costs? The questions of how strongly export performance depends on trends in real effective exchange rates, and which price or cost indicator is the most relevant in this respect, have long been discussed in the literature (BIS 1993; Chinn, 2006). However, recent empirical investigations have often found a rather low explanatory power of price and cost indicators for the export performance (ECB, 2012; Gaulier and Vicard 2012; ECB, 2014). Furthermore, they have often failed to show the dominance of one specific indicator when tested within standard export equations (Christodoulopoulou and Tkacevs, 2014; Ca'Zorzi and Schnatz, 2007; Juks, 2003).

One reason for the unsatisfactory performance of aggregate export equations may be an inadequate adjustment for differences in the quality of traded products (Benkovskis and Wörz, 2013). Second, cost and price developments in exporting sectors might differ from those in sectors oriented at domestic demand (Gaulier and Vicard, 2012). In particular in countries in the process of catching up, but also in countries subject to a housing bubble, unit labour cost developments in the internal sectors and in the trade oriented sectors may diverge substantially. Competitiveness measures such as the real effective exchange rate (REER) based on aggregate price or unit labour cost developments might thus give misleading signals of the country's external competitiveness. Third, products are increasingly not produced in one country but within cross-border production chains (Amador et al., 2015; Amador and di Mauro, 2015). Due to the increasing importance of GVCs (global value chains), the relationship between aggregate domestic prices and exports might be distorted (Bems and Johnson, 2012; IMF 2013; Johnson, 2014; di Mauro and Ronchi, 2015). Traditionally, exports are measured in gross terms, and may embody imported goods, the prices of which are unrelated to domestic production costs. Price and cost competitiveness depends not only on domestic trends but also on the nature of the value chain and the costs of imported components (IMF, 2013). With trade in "tasks" instead of products (Johnson, 2014), the traditional real effective exchange rates may not be informative enough anymore as competitiveness relates to factors of production.

In the literature, a number of price and cost competitiveness indicators that account for the increasing importance of GVCs have already been proposed. Bems and Johnson (2012) suggested that with value added trade the adequate measure of price competitiveness is the value added real effective exchange rate (VA-REER). Based on a model in which consumers directly purchase value added instead of final consumer products from different countries, the authors show that the conventional

Armington-based formula for the REER can be retained, but instead of consumer prices, a proxy for the price of domestic value added, the GDP deflator, needs to be employed. Also, the country weights should stem from bilateral trade flows in value-added terms. Bems and Johnson show that a VA-REER derived from value added trade data can deviate markedly from conventional rates based on the CPI and trade weights from gross flows. However, it is mainly the choice of the relevant price, i.e. the deflators instead of CPI, and not the weighting of countries according to value-added trade, which makes the difference when compared with the traditional gross trade based REER.

Bayoumi et al. (2013) proposed to retain the REER designed to explain gross trade (i.e. trade in products) but include the price of imported intermediate inputs into the real effective exchange rate measure. Their REERs thus takes into account all production costs, domestic and foreign. Patel et al. (2014) derived theoretically a new REER measure that incorporates information about linkages and sector-specific (intermediates, final) demand and prices. The aggregate REER is built from the sectoral REERs, thus taking into account that demand elasticities may differ and that the sector level REER can vary markedly. The authors show that such REER can also deviate perceptibly from the aggregate REER based on CPI or GDP deflators.

While a number of new price or cost competitiveness indicators relevant for value added trade has been proposed in the literature, a test of the empirical performance of new exchange rate measures in explaining export dynamics in gross or value added terms has been left to later research. To some extent, this might have been due to the fact that the necessary data for an empirical investigation were not publicly available. Only a few years back, two databases containing information about interconnectedness on a sector and country level, and on value added trade, got published with open access (World-Input-Output Database, WIOD, Timmer, 2012; Timmer et al., 2015; and Trade in Value Added, TiVA, OECD/WTO, 2013).

Our aim is precisely the empirical evaluation of value added real effective exchange rates. We take up the suggestion by Bems and Johnson (2012) that with the increasing importance of GVCs, we should focus on value added trade and on VA-REERs. Their model enables us to pose an easily applicable testable hypothesis, and to compare the explanatory power of traditional and value added REERs within a single framework. Thus, the main objective of our research is to econometrically test and compare the explanatory power of traditional and value added REER measures within the framework of standard aggregate export equations. However, while the VA-REER as suggested by Bems and Johnson (2012) is our point of reference, we add two further aspects. First, to sharply fo-

cus on external competitiveness, we introduce a new real effective exchange rate indicator, which measures the price and cost trends in the sectors that actually export. The basic intuition goes back to Gächter et al. (2013). It contrasts with conventional measures of economy-wide deflators or unit labour costs, in which the individual sectors are (implicitly) weighted according to their share in total value added. With the newly available information about value added trade on a sectoral level, it is possible to identify the sectors that supply the exported value added more precisely than with a "traditional" approximation of the industries into "tradables" and "non-tradables". Second, we consider unit labour costs, and not deflators, as the best representation of competitiveness in terms of value added because these might be more decisive when choosing the location of a cross border production chain. Nevertheless, to compare the performance of traditional and newly developed REER measures, the tests are performed for a broad range of real effective exchange rates.

The article is structured as follows. In Section 2 we briefly present our empirical strategy including the testable relation, which is a standard export equation estimated in a country panel framework. The main contribution of the paper is the application of this method on a new dataset that focuses on value added exports and value added real exchange rates. Both variables, however, are not readily available. The principal obstacle for our investigation is the absence of value added trade data in volume terms. In Section 3 we therefore first introduce the available data sets on value added trade in current prices. We then discuss the relevant price measures to be applied for deflation and for measuring competitiveness in value added terms (i.e. computing real effective exchange rates). Section 4 presents the resulting data included in the estimations, i.e. real exports, demand from the trading partners and the real effective exchange rates in gross and value added terms. Section 5 presents the results for the entire country panel and for selected country groups. Section 6 concludes.

2. Outline of the investigation

The empirical investigation is straightforward as we estimate, for a panel of countries, standard export equations, i.e. relations between export growth, demand growth and changes in the relative prices (real effective exchange rates):

$$X_t = c + \alpha \cdot EXTD_t + \beta \cdot REER_t + \gamma \cdot z_t ,$$

with *X* denoting exports, *EXTD* external demand by trade partners, *REER* the real effective exchange rate and *z* other determinants. Our main interest is to identify possible differences in the estimated connections when exports, demand and real effective exchange rates are measured in gross versus value added terms. The principle distinction between the estimated equations therefore relates to

the measurement of included variables in gross or value added terms. To test whether and how exports are related to competitiveness, we consider a variety of REERs, traditional and value added based (Table 1). All of these variables are introduced and described in more detail in the following sections.

Table 1: Basic structure of estimated relationships

	Trade volumes, country weights measured in… terms	
	GROSS	**VALUE ADDED**
EXPORTS	Real exports of goods and services, national accounts	Deflated value added exports
DEMAND	Weighted gross real imports of goods and services by trading partners, national accounts	Weighted deflated value added imports of trading partners
REAL EFFECTIVE EXCHANGE RATES	CPI (gross country weights)	CPI (VA country weights)
	DEFL (gross country weights)	DEFL (VA country weights)
	ULC (gross country weights)	ULC (VA country weights)
	DXGS (gross country weights)	DXGS (VA country weights)
	Trade-weighted unit labour costs (gross sector and country weights)	Trade-weighted unit labour costs (VA sector and country weights)
	Trade-weighted deflators (gross sector and country weights)	Trade-weighted deflators (VA sector and country weights)

Note: 'VA' stands for 'value added', 'CPI' for 'consumer price index', 'DEFL' for GDP deflators, 'ULC' for economy-wide unit labour costs, 'DXGS' for export deflators from the national accounts. The trade-weighted unit labour costs and trade weighted deflators are defined and presented in Section 3.2 of the text.

3. Value added trade in current prices and volume terms

3.1. Value added trade in current prices according to the World Input-Output Database (WIOD)

It is a well-established fact by now that owing to the increasing role of cross-border production and supply chains, gross export data may overstate actual income generated by external trade (Baldwin and Gonzales, 2013; Sturgeon, 2013).[2] However, no official statistics on value added in trade exist, which complicates empirical evaluation of the link between value added exports and price or cost

[2] However, that bias might have been reduced with the transition to the most recent international standard in balance of payments compilation (BPM6).

competitiveness. So far, value added in exports and the income generated through external trade has had to be derived from available official statistics.

Hummels et al. (2001) proposed in their pioneering work to identify value added trade through combining information about the flows of intermediate and final products from the national input-output (IO) tables with information about cross-border flows of intermediates and final products. Starting from this suggestion, a number of approaches and databases have been developed (Johnson and Noguera, 2012; OECD/WTO, 2013; Timmer, 2012), and the research is still ongoing. Two of these databases are at least partly publicly available: the World Input-Output Database (WIOD; Timmer, 2012; Timmer et al., 2015) and the TiVA from the OECD/WTO (2013).[3] WIOD contains annual IO tables, including a decomposition of external trade flows, for 1995-2011 in current USD prices and in gross terms for 40 advanced and emerging countries (and adds the rest of the world combined) and 35 sectors. For TiVA, the underlying Intercountry-Input-Output (ICIO) tables have not yet been published, but information about VA trade for 57 countries, including about its sector composition for 18 sectors, has been released for selected years, starting with 1995.

Due to the availability of annual data, and because it is accompanied by Socio-Economic Accounts (SEA) containing sector-specific information on labour compensation, deflators and labour input,[4] we base our research on the WIOD.[5] Value added trade (in current USD) was derived from gross external trade data in current USD as in Koopman et al. (2011). This corresponds to 'value-added exports' defined in Johnson and Noguera (2012) and also to 'domestic value added embodied in foreign final demand' in the TiVA database.[6] Table A1 in the Appendix presents basic information about the export data in gross and value added terms for the 38 countries included in our investigation. The first three columns contain the average annual growth rates of gross exports from national accounts, gross exports from the WIOD and value added exports (in current prices, VAX) from the WIOD (the latter two converted into national currency). Gross data from the two data sources appear to be rather similar, both in terms of annual average growth (columns 1-2) and in terms of dynamics over time as indicated by correlation coefficients (column 6). In line with the increasing importance of

[3] The WIOD is available for the general public at www.wiod.org. The TiVA data base can be accessed via https://stats.oecd.org.

[4] The full set of SEA is currently available from 1995 to 2009.

[5] However, where possible, we exploit information from TiVA for comparison (robustness checks). That is possible in particular with respect to the sector and country composition of exports; it is not possible to compute annual growth rates of VA trade from TiVA. In general, however, the differences between the two databases, which – at least judging from the information available – do not appear fundamental, should not give rise to a substantially different assessment of the link between exports and VA based cost and price competitiveness.

[6] *Domestic Value-Added embodied in Foreign Final Domestic Demand* shows how industries export value both through direct final exports and via indirect exports of intermediates through other countries to foreign final consumers. They reflect how industries are connected to consumers in other countries, even where no direct trade relationship exists. This measure can thus be interpreted as "exports of value-added". For more details see OECD (2013).

cross-border supply chains, value added trade grew at a slower pace in most cases (column 3), but the dynamics are still rather similar to those of gross trade (correlation coefficients in columns 7-8).

The WIOD database furthermore presents a sector and country decomposition of gross and VA trade. This is of importance for the computation of real effective exchange rates (composition of the trading partners in gross and value added terms), but also for the construction of price indices that relate specifically to the exporting sectors and hence to export competitiveness. WIOD contains a sectoral breakdown of exports into 36 sectors, which have been aggregated by us to 18 sectors (corresponding to the sectoral breakdown of TiVA; OECD/WTO, 2013). The choice of a higher aggregation level is motivated by the fact that the computation of world IO tables entails a number of transformations and approximations. In particular the most disaggregated data might be biased and need to be treated with great caution (OECD, 2013). The list of sectors as well as the transformation scheme from 36 to 18 sectors can be found in Table A2 in the Appendix.[7]

The sector shares in gross and value added trade can differ substantially. Manufacturing dominates gross exports of most countries but not necessarily also trade in value added terms. Here, services, and most importantly business services, gain in importance.[8] The sectoral composition of value added trade is thus closer to that of the whole economy. What has to be kept in mind in this respect is that the shifts do not occur because of imported inputs but because of the intermediates sourced from *within* the respective economies. What these value added data show is how *domestically sourced* intermediates, mainly services, are used to produce export goods. It is also necessary to be aware of the fact that the product perspective is replaced by an industry perspective related to domestic income generation, with important consequences for the identification of the "price" of the exported "item". The "exported item" can be an intermediate service supplied by a domestically oriented service sector. As a result, these data illustrate the complexity of defining sectors that produce tradable and non-tradable goods. According to these data, most sectors contribute in some way to the production of goods and services that are finally absorbed by foreign countries. As regards the deviations of country shares for gross and value added trade, these appear less pronounced than those of the sector shares. Nevertheless, the United States typically gain in importance.

To summarise, according to WIOD, gross trade and value added trade in current prices are reasonably similar in their dynamics over time (not in the actual magnitude). However, the sectoral composi-

[7] Sector 23 "Coke, Refining Petroleum and Nuclear Fuel" was excluded due to its sensitivity to commodity prices; sector P "Private Households with Employed Persons" was dropped because of missing data.
[8] See Table A3 in the Appendix for sector weights according to gross and VA trade, and Table A4 for the country weights for Austria and Portugal, which were chosen as examples here.

tion can deviate markedly, with the composition of value added trade being more similar to the total economy than the composition of gross trade.

3.2. The price and competitiveness of value added: TWDEFL and TWULC

Since aggregate value added exports are the sum of sectoral value added exports, for the derivation of export volumes, the sector-specific deflators from the SEA accompanying WIOD are weighted according to their share in value added exports (forming the 'trade-weighted deflators', TWDEFL):

$$TWDEFL^k = \sum_{i=1}^{n} defl_i^k * w_i^k$$

with the sector-specific weight being $w_i^k = x_i^k / X^k$ with $X^k = \sum_{i=1}^{n} x_i^k$, where *k* denotes the country, *i* is one of *n* sectors, *x* is exports and *defl* is the deflator.

Deflators are the appropriate index to compute volume measures of value added. However, when it comes to measuring external *competitiveness* that decides about the location of cross-border production chains, unit labour costs appear to better capture the underlying idea that an increase in this component implies a worsening of the competitive position of a producer. Deflators do not include only direct costs arising from labour but also a number of other potential components, the most important of which are profits and dividends. Because it is (expectations of) these that may have decided about relocation, outsourcing or entering an international value chain in the first place, their dynamics may not fully reflect the price or cost competitiveness of the exporters as conventionally understood. High deflators that do not stem from labour costs but from profits are unlikely to lead to adjustments on the part of the producer. Therefore, our main measure of *competitiveness* to be used in real effective exchange rates is based on unit labour costs, even if we consider a range of other price measures in the tests for comparison.

We focus on export competitiveness in the *sectors that actually export*. The basic idea behind sector-specific trade-weighted indicators is that in any given country price or cost dynamics in industries that actually export might differ from those in more inward oriented industries (Gächter et al., 2013). First, firms in sectors with strong international competition might be more concerned about maintaining price competitiveness even when domestic demand is booming. Second, as regards labour costs, substantially larger differences can be observed in productivity trends across sectors than in

the wage developments, owing to e.g. different capital intensity.[9] This, combined with micro-level data analysis (András Puchal et al., 2010, ECB, 2014) that exporting firms are typically larger, more innovative and more productive than inward oriented firms,[10] suggests that in outward oriented sectors price and cost trends may be more contained than in the overall economy and, ultimately, decisive for export performance.

Our main *competitiveness* indicator, the trade-weighted unit labour costs (TWULC), weights the sectoral unit labour costs in accordance with the share of the respective sector in a country's exports:

$$TWULC^k = \sum_{i=1}^{n} ulc_i^k * w_i^k$$

with the sectoral weight being $w_i^k = x_i^k / X^k$ with $X^k = \sum_{i=1}^{n} x_i^k$, where *k* denotes the country, *i* is one of *n* sectors, *x* is exports and *ulc* is nominal unit labour costs, calculated as $ulc_i^k = comp_i^k / va_i^k$, i.e. compensation per employee to real value added per person employed. The export weights are derived from gross and value added exports, to be related with the corresponding export measure.

Table 2 presents summary statistics for eight alternative price and cost measures: The first two columns show the TWULC, using sector weights derived from either gross or VA exports (WIOD) and fixed through time (year 2000). Columns 3 and 4 repeat the exercise with deflators (TWDEFL). As benchmarks, Table 2 adds four additional conventional price and cost measures: aggregate unit labour costs (ULC), GDP deflators (DEFL), consumer prices (CPI) and gross export prices from the national accounts (XGS-DEFL). Generally, variation between these price variables can be high, potentially also affecting the assessment of external competitiveness. Also, the data confirm our hypothesis that the trade-weighted unit labour costs and the trade-weighted deflators have typically increased less than the overall unit labour costs and deflators. Exceptions are primarily countries with either an export specialisation on commodities or with a spell of high inflation during the observation period.

[9] These differences are most pronounced in countries in a catching-up process where productivity in capital-intensive sectors is growing rapidly, and demand for non-tradable goods, which are typically produced with lower capital intensity and lower productivity growth, is booming (Balassa, 1964; Samuelson, 1964).

[10] Causality appears to go mainly in the direction of only highly productive firms starting to export due to involved fixed costs. But there may also be "learning by exporting" effects.

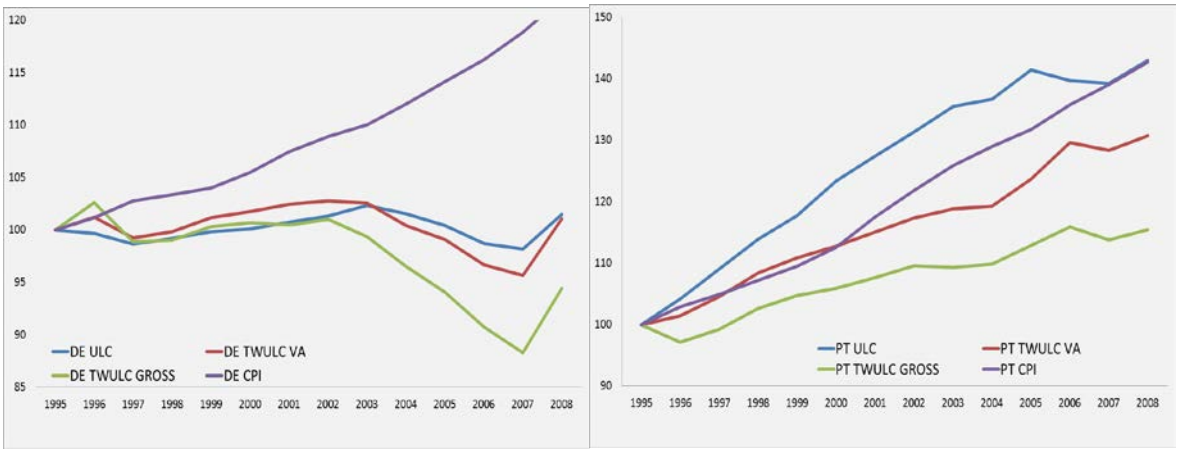
Table 2: Summary statistics for the price measures, annual average growth rates 1996-2008

	TWULC VA	TWULC GROSS	TWDEFL VA	TWDEFL GROSS	ULC	DEFL	CPI	XGS-DEFL
average annual growth rate								
euro area (excluding NMS) plus Denmark								
AUT	0.7	0.3	0.8	0.6	0.7	1.2	1.7	1.1
BEL	1.3	0.8	1.1	0.5	1.6	1.7	2.0	1.4
DNK	2.4	2.4	2.3	2.1	2.8	2.3	2.1	1.9
FIN	-0.5	-1.9	-0.6	-2.0	1.3	1.5	1.7	-0.4
FRA	0.5	-0.2	0.2	-0.7	1.6	1.8	1.8	0.5
DEU	0.1	-0.4	0.3	0.2	0.1	0.6	1.5	0.3
GRC	1.9	0.1	2.5	2.2	4.5	3.9	4.0	3.8
IRL	2.9	2.3	2.1	1.4	3.7	3.4	3.0	0.9
ITA	2.5	2.4	2.3	2.1	2.5	2.7	2.5	1.7
LUX	3.8	3.7	3.1	3.3	3.2	2.9	2.5	3.3
MLT	3.6	3.4	2.1	2.0	2.8	2.1	2.7	2.2
NLD	1.4	0.7	1.7	0.9	2.0	2.3	2.2	1.3
PRT	2.1	1.1	2.0	1.5	2.8	2.9	2.8	1.6
ESP	2.6	2.2	2.8	2.4	3.1	3.5	3.0	2.3
developed economies (not euro area)								
AUS	2.7	2.6	3.7	3.7	2.5	3.3	2.7	4.0
CAN	2.1	2.2	1.9	1.2	2.0	2.1	2.1	1.6
JPN	-3.0	-4.2	-2.6	-3.9	-1.8	-1.1	0.1	-0.6
SWE	0.4	-1.7	-0.2	-2.5	1.4	1.5	1.3	0.4
GBR	2.1	1.6	1.9	0.9	2.7	2.7	1.8	0.8
USA	0.8	-0.5	0.8	-0.5	1.9	2.1	2.7	1.3
emerging economies (not EU)								
BRA	9.4	10.1	9.9	10.1	8.1	8.2	7.2	9.3
CHN	0.9	0.6	2.5	2.3	1.2	3.2	2.1	1.1
IND	4.0	4.0	4.9	4.3	4.5	5.0	6.1	5.1
IDN	15.1	14.0	16.5	14.8	13.4	14.6	12.7	14.8
KOR	0.0	-1.3	0.5	-0.8	1.2	1.8	3.5	0.5
MEX	8.7	8.5	10.3	9.8	10.1	11.2	10.0	8.8
RUS	23.9	24.3	23.6	24.3	23.4	23.2	22.0	22.3
TUR	33.0	32.0	30.7	27.8	33.1	33.5	38.4	33.9
"new" member states (EU)								
BGR	34.1	32.6	34.6	35.6	34.6	34.8	36.8	33.5
CZE	5.5	3.7	2.7	1.6	6.8	4.0	4.3	0.2
EST	6.2	4.6	6.1	5.1	7.7	7.7	6.7	5.6
HUN	6.9	3.2	7.5	4.9	8.2	9.0	9.3	4.7
LVA	8.7	7.5	7.4	6.3	8.7	8.2	6.6	6.3
LTU	5.7	4.7	4.3	3.7	5.8	5.0	4.8	3.5
POL	3.1	1.6	4.8	3.2	3.4	6.0	6.4	4.9
ROU	34.4	33.2	32.3	32.4	33.6	33.2	30.9	27.1
SVK	5.0	2.3	3.7	1.5	5.0	4.7	6.2	3.0
SVN	3.7	2.4	4.9	4.2	4.9	6.0	6.2	4.6

Notes: 'ULC' stands for aggregate unit labour costs, 'TWULC GROSS' for the trade-weighted unit labour costs with gross trade weights, 'TWULC VA' for the trade-weighted unit labour costs with value added trade weights, 'DEFL' is the aggregate GDP deflator, 'TWDEFL GROSS' for the trade-weighted sectoral deflators with gross trade weights, 'TWDEFL VA' for the trade-weighted sectoral deflators with value added trade weights, 'CPI' is the consumer price index and 'XGS-DEFL' is the export deflator from the national accounts. Source of data: WIOD, IMF, own calculations.

When comparing the various trade-weighted indicators, it is the indicator based on gross trade that has typically increased less than the indicator based on value added trade (see also Graph 1 on page 11 for Germany and Portugal). In gross trade, manufacturing sectors have a higher weight than in the value added exports, which include the intermediates sourced in the domestic economy and thus give a higher weight to services. Because unit labour costs in service sectors have often grown more than those in industry, this yields the stronger growth in the value added trade based ULCs or deflators. Still, what has to be kept in mind is that notwithstanding the fact that the TWULC and TWDEFL were derived focusing on the exporting sectors, the sector-specific deflators or ULC do not reflect only the trends or developments in exporting firms but that of the entire sector. The aggregate or average deflator of a sector may, but need not reflect primarily the development in the exporting firms.

Graph 1: Trade-weighted and aggregate unit labour costs, Germany and Portugal



Notes: 'ULC' stands for aggregate unit labour costs, 'TWULC GROSS' for the trade-weighted unit labour costs with gross trade weights, 'TWULC VA' for the trade-weighted unit labour costs with value added trade weights, and 'CPI' denotes the consumer price index.

The magnitude of the deviation between the trade-weighted indicators and the overall unit labour costs or deflators can differ markedly. For instance, in Germany and in Austria, the increase in the TWULC based on value added trade is practically the same as that of total economy unit labour costs (with total unit labour costs growing only very modestly). In Greece, with quite vigorous economy-wide unit labour cost dynamics, the TWULC grew substantially less. In the group of emerging economies outside of the EU, but also in Bulgaria, there are numerous countries with an increase in the trade-weighted price and cost indicators above that of the total economy. In addition to the above mentioned cases of commodity exporting countries this also applies to countries (e.g. Bulgaria) with a past high inflation period that might have disturbed relative cost and price relationships. The low-

est increase (actually a decline) in the TWULC could be observed in Japan. Weak dynamics were identified in Finland, Germany, Sweden, the United States and Korea.

The growth rates of the TWDEFL, used to deflate value added exports, can deviate substantially from the conventional export deflators in the national accounts. Often (in 25 countries), the trade-weighted deflators according to VA trade have increased more than the export deflators from the national accounts. In the case of the gross trade weighted TWDEFL, where the sector composition should be the closest to the deflators from the national accounts, it is still 17 countries where the sector-specific deflators have increased more than the export deflators. From the information available, the origin of these differences cannot be identified. One reason might be that the sector-specific deflators and unit labour costs cover both exporting firms and firms that supply the domestic markets, with the price and cost trends in domestically oriented firms being more vigorous than in those exposed to international competition. Another potential cause might be the cost-containing effect of imported intermediates on gross export prices. What is relevant in this respect, however, is that the two export measures included in our research (gross trade from the national accounts, deflated value added trade) differ also because they were deflated with different measures of inflation: gross export prices and trade-weighted deflators, respectively.

To summarise, the focus on exporting sectors in gross and value added terms shows that price trends can differ not only from those shown in aggregate indicators such as the CPI, economy-wide unit labour costs and deflators but also between those expressed in gross and value added terms. Indicators relating to exporting sectors and gross trade typically show the most favourable picture of a country's price trends.

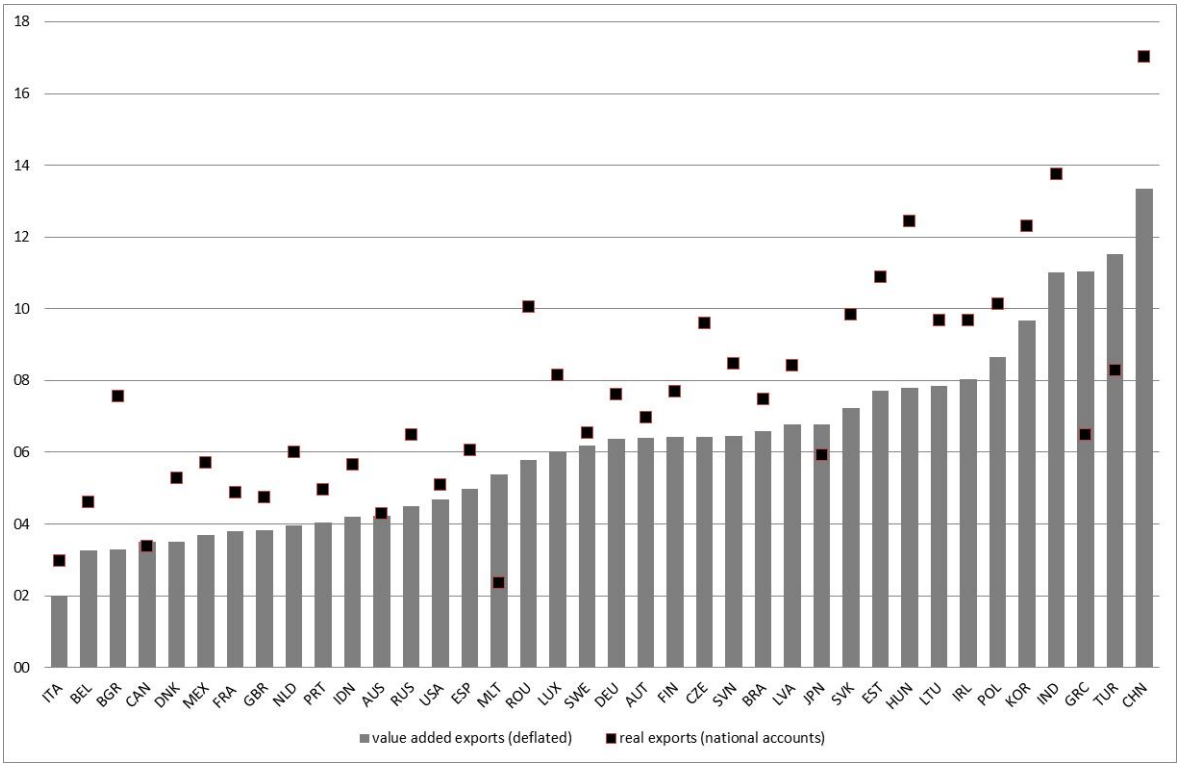
4. The variables included in the tests

4.1. Real exports and demand from the trading partners

Based on the data presented above, real exports in value added terms were computed by dividing value added exports derived from WIOD (VAX) with the TWDEFL. Real exports in gross terms are taken from the national accounts (IMF WEO database). Graph 2 indicates that during 1995 – 2008 the highest growth rate in deflated value added exports was observed in China and the lowest in Italy. Overall, the differences between value added exports and gross exports can be substantial, which contrasts with the observation that the dynamics are relatively similar in nominal terms. The average annual growth rates of value added trade are lower than those of gross trade, the differences being as high as 4 pp p.a. What is more, the dynamics as reflected in the correlation between the annual

average growth rates of the two deflated series deviate more strongly than for the nominal series (column 9 in Table A1 in the Appendix). Correlation is below 0.5 in six cases (e.g. Brazil, Russia), and above 0.9 in only nine cases. The quite substantial differences between the deflated exports in VA terms and that of gross exports arise not only from the elimination of foreign-sourced intermediates in the former but also, and possibly mainly, from the measures used for *deflation*: it is export prices in the case of the national accounts and trade-weighted sectoral deflators (TWDEFL) in the case of value added trade.

Graph 2: Average annual growth rate of gross and value added exports in real terms



Source: WIOD, IMF, own calculations. Value added exports are derived from data in WIOD (see text for details), real exports from the national accounts are from the IMF WEO database.

Gross demand from the trading partners is measured by weighted gross real imports from the national accounts (applying gross country weights). Real value added imports were derived from WIOD due to the fact that value added import flows in current USD are part of the value added trade matrix. To compute the demand of the trading partners *n* of country *i* ($EXTD_i$), the value added imports of each country *n* (VAM^n) had to be converted to national currency at current exchange rate, deflated and weighted according to the shares in exports of the country in question (country *i*):

$$EXTD_i = \alpha_i^1 \frac{VAM^1}{MTWD^1} + \alpha_i^2 \frac{VAM^2}{MTWD^2} + \dots ,$$

for country *i* trading with the other countries (denoted with numbers, so n=1…37 in our investigation, export weights α^n) and $MTWD^n$ being the VA import deflators of countries *n*. The import deflators were also derived from the available information in WIOD and SEA. The trade weighted export deflators (TWDEFL) of import trade partners of a country *n* were converted into the currency of country *n*, while the weighting scheme reflects the import composition. The MTWD of country *n* was thus computed as:

$$\mathrm{MTWD_n} = \beta_n^1 * \mathrm{TWDEFL}^1 * \mathrm{NER}_n^1 + \beta_n^2 * \mathrm{TWDEFL}^2 * \mathrm{NER}_n^2 + \ldots$$

We had to assume full pass-through of the deflators into the import prices of the importing country.

4.2. The real effective exchange rates

The real effective exchange rates are computed according to the following formula:
$REER_k = \sum_{j=1}^{n} \frac{p_k}{p_j * E_j} w_j$, with E_j denoting the bilateral exchange rate of country *k* to partner country *j*, w_j the weight attached to country *j*, reflecting its importance as export partner and p_k and p_j the price indices in countries *k* and *j* respectively.

The price indices presented above (TWULC, TWDEFL, ULC, DEFL, CPI, XGS-DEFL) give rise to twelve REER measures as all indices enter alternatively with gross and value added trade based country weights. The REERs in gross terms ("traditional") contain gross country weights and "gross" price indicators (relevant only for the TWULC and TWDEFL, in this case the sectors are weighted according to their share in gross exports). The REERs in value added terms are based on VA weights and VA price indicators (for TWULC and TWDEFL). All real effective exchange rates are computed equally, and they are therefore fully comparable. The country weights stem from bilateral trade flows in gross or value-added terms. All indicators are calculated with fixed weights of the year 2000. Table 3 presents annual average growth rates of the twelve REERs; Table A5 in the Appendix shows the correlations between the annual growth rates of all series and the REER-CPI with gross country weights, the most frequently used "traditional" real exchange rate.

Table 3: Real effective exchange rates included in the investigation, annual average growth rates between 1996 and 2008

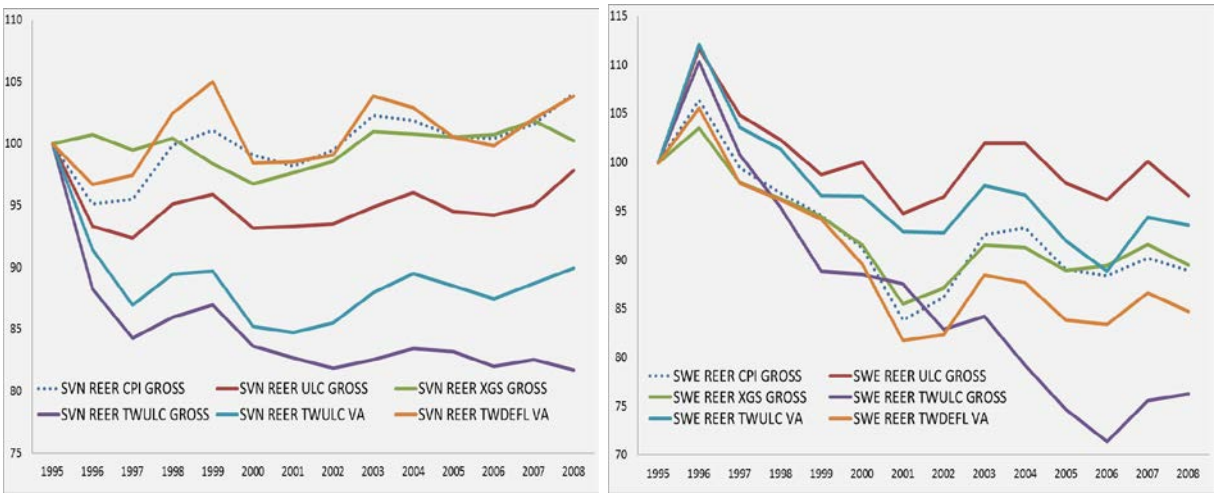
REER…	TWULC VA	TWULC GROSS	TWDEFL VA	TWDEFL GROSS	ULC GROSS	ULC VA	DEFL VA	DEFL GROSS	XGS DEFL VA	XGS DEFL GROSS	CPI VA	CPI GROSS
	annual average growth rate											
	euro area (excluding NMS) plus Denmark											
AUT	-0.6	-0.4	-0.6	-0.3	-1.2	-1.1	-0.9	-1.0	-0.3	-0.3	-0.7	-0.8
BEL	0.1	0.1	-0.2	-0.2	-0.3	-0.2	-0.4	-0.4	0.1	0.1	-0.2	-0.2
DNK	1.8	2.7	1.6	2.4	1.5	1.5	0.7	0.7	1.1	1.1	0.3	0.3
FIN	-1.8	-2.5	-1.9	-2.6	-0.7	-0.5	-0.7	-0.8	-1.8	-1.9	-0.7	-0.7
FRA	-0.5	-0.6	-0.8	-1.2	0.0	0.1	0.0	-0.1	-0.5	-0.5	-0.2	-0.3
DEU	-1.3	-1.3	-1.2	-0.6	-2.1	-1.9	-1.8	-1.9	-1.1	-1.2	-0.9	-1.0
GRC	0.2	-1.2	0.7	0.9	2.0	2.2	1.2	1.0	1.8	1.7	1.0	0.7
IRL	2.5	2.6	1.6	1.8	2.6	2.6	2.0	2.0	0.4	0.4	1.5	1.5
ITA	2.7	3.3	2.3	2.8	1.8	2.0	1.8	1.7	1.6	1.5	1.3	1.2
LUX	2.7	3.1	1.8	2.8	1.5	1.5	0.9	0.9	2.1	2.0	0.3	0.3
MLT	3.5	4.1	1.9	2.7	2.1	2.2	1.1	1.0	2.0	2.1	1.5	1.4
NLD	0.2	0.2	0.5	0.3	0.3	0.3	0.3	0.3	0.1	0.1	0.0	0.1
PRT	1.0	0.5	0.9	0.8	1.1	1.1	1.0	0.9	0.5	0.4	0.8	0.7
ESP	1.5	1.6	1.6	1.8	1.3	1.4	1.5	1.4	1.1	1.1	0.9	0.8
	advanced economies (not euro area)											
AUS	4.2	5.4	4.8	6.1	3.4	3.1	3.4	3.6	4.5	4.7	2.4	2.6
CAN	3.2	4.6	3.0	3.5	2.1	2.1	2.0	2.0	2.2	2.2	1.5	1.5
JPN	-4.8	-5.2	-4.8	-5.1	-4.2	-4.3	-4.1	-4.1	-2.9	-2.8	-3.2	-3.1
SWE	-0.5	-2.1	-1.3	-3.0	-0.3	-0.1	-0.4	-0.5	-0.8	-0.8	-0.8	-0.9
GBR	1.9	2.0	1.6	1.3	1.6	1.8	1.5	1.4	0.3	0.2	0.3	0.2
USA	-0.9	-1.9	-1.3	-2.1	-0.6	-0.3	-0.7	-0.9	-0.7	-0.9	-0.1	-0.3
	emerging economies (not EU)											
BRA	2.4	3.8	2.7	3.7	0.4	0.4	0.2	0.2	1.9	1.9	-1.0	-1.0
CHN	2.1	2.9	3.5	4.5	1.6	1.5	3.2	3.3	1.5	1.6	1.6	1.7
IND	0.3	1.1	1.0	1.4	0.1	0.1	0.2	0.2	1.0	0.9	0.9	1.0
IDN	3.1	3.3	4.0	3.6	1.0	0.8	1.3	1.4	1.8	2.0	-1.0	-0.9
KOR	-3.4	-3.8	-3.3	-3.8	-2.9	-3.0	-3.0	-3.0	-3.6	-3.6	-1.5	-1.4
MEX	3.2	4.1	4.7	5.4	3.4	3.5	4.4	4.4	2.8	2.8	2.8	2.7
RUS	6.7	7.7	6.3	7.4	5.4	5.7	5.1	4.8	5.2	5.0	3.7	3.3
TUR	1.0	0.8	-0.9	-2.6	0.4	0.5	0.6	0.5	1.6	1.5	4.0	3.9
	"new" EU member states											
BGR	4.2	3.3	4.6	5.8	3.7	4.0	3.9	3.6	3.6	3.3	5.1	4.7
CZE	7.0	6.0	4.1	3.4	8.0	7.9	4.7	4.6	1.5	1.5	4.6	4.4
EST	4.5	3.9	4.5	4.6	5.1	5.2	5.0	5.0	4.0	4.1	4.1	4.1
HUN	2.7	-0.2	3.1	1.2	3.6	3.5	3.8	3.9	0.4	0.5	3.7	3.7
LVA	7.1	6.2	5.8	5.1	6.2	6.7	5.8	5.5	4.8	4.5	4.1	3.9
LTU	7.2	6.5	5.7	5.4	6.6	7.0	5.7	5.3	4.9	4.6	5.5	5.2
POL	1.1	0.3	2.8	1.6	1.0	1.0	3.3	3.3	2.9	2.9	3.3	3.3
ROU	8.9	8.5	7.2	7.7	7.6	7.8	7.0	6.8	2.9	2.7	4.7	4.5
SVK	4.8	2.5	3.6	1.6	3.9	4.4	3.9	3.6	3.3	3.1	5.0	4.6
SVN	-0.8	-1.5	0.3	-0.1	-0.2	-0.1	0.6	0.6	0.1	0.0	0.4	0.3

Notes: 'ULC' stands for aggregate unit labour costs, 'DEFL' for aggregate (GDP) deflators, 'TWULC GROSS' for the trade-weighted unit labour costs with gross trade weights, 'TWULC VA' for the trade-weighted unit labour costs with value added trade weights, 'TWDEFL GROSS' for the trade-weighted sectoral deflators with gross trade weights, 'TWDEFL VA' for the trade-weighted sectoral deflators with value added trade weights, 'XGS DEFL' for the gross trade export prices from the national accounts, and 'CPI' denotes the consumer price index.

With regard to the trade-weighted REERs it is interesting to observe that it does not imply much for the relative trends between countries whether exporting sectors have posted lower growth of unit labour costs (or deflators) than those in more domestically oriented sectors. For instance, between 1995 and 2008 the overall unit labour costs grew by 1.5 % in Germany, which is actually on par with

the increase in the value added trade-weighted unit labour costs. But because the trade-weighted unit labour costs of the trading partners have in general developed more favourably than the overall unit labour costs, the depreciation of the German real effective exchange rate has been less pronounced when the trade-weighted indicator is looked at. In Portugal, the VA trade-weighted unit labour costs grew by 34 % between 1995 and 2008, about 10 pp less then overall unit labour costs. Nevertheless, since the deviation between unit labour cost developments in the exporting and in the domestically oriented sectors was even larger in the trade partners than in Portugal, until 2008 the REER appreciation was broadly similar for the TWULC and the overall ULC. By contrast, in Japan, the deviation between the trends in overall unit labour costs and those in the exporting sectors was particularly large, which yields a specifically strong real depreciation of the yen in terms of the TWULC. As a result, the fact that prices or costs may have developed more favourably in the exporting sectors within a country does not automatically translate into preservation of competitiveness of the exporting sectors. What matters is the relative trend towards the exporting sectors of other countries.

Graph 3: Real effective exchange rates with aggregate and sector-specific price indices, Slovenia and Sweden



Note: 'SVN' stands for Slovenia, 'SWE' for Sweden. 'REER' denotes real effective exchange rate, 'CPI' the consumer price index, 'ULC' aggregate unit labour costs, 'XGS' the deflators of gross exports from the national accounts, 'TWULC' the trade weighted sectoral unit labour costs and 'TWDEFL' the trade weighted sectoral deflators. 'GROSS' indicates that the country weights stem from gross export data, 'VA' country weights from value added trade data.

The various REERs for an individual country can differ substantially, and this variation is not uniform across countries. The average range of the average annual rates of change in the REER over all countries is 2.8 pp. That would imply an average difference between the REER with the lowest change and that with the highest change of more than 40 % over the examined time period. As an example, the gross sector-specific trade weighted REER (with ULC or deflators) for Sweden indicates a steady im-

provement in competitiveness of 2-3 % per annum. Using total economy ULC, with gross or VA weights, the REER remained more or less stable (Graph 3). In a few countries, some REERs point to an appreciation and others to depreciation over the studied period (Turkey, Brazil, Slovenia, Greece and with reservations also Belgium and France). Also the correlations between the annual rates of change of the individual REERs can be low in some cases (Table A5 in the Appendix) even if they are in general rather high. The largest deviations are found for the export deflators. Differences between gross and value added trade weighted REERs for the same price index appear limited, with the exception of the sectoral indicators, where the underlying price indices differ.

5. Results of the econometric tests

In the standard export equations

$$X_t = c + \alpha \cdot EXTD_t + \beta \cdot REER_t + \gamma \cdot z_t ,$$

with *X* denoting exports, *EXTD* external demand by trade partners, *REER* the real effective exchange rate, we added two additional variables (*z*) to account for other sources of heterogeneity: productivity growth (in the trade-weighted sectors) as a proxy for supply effects, and the share of value added exports in gross exports as a proxy of the involvement in global supply chains. The hypothesis is that higher productivity or stronger incorporation into GVCs (implying a lower ratio of value added exports over gross exports) will tend to imply higher gross exports growth, and potentially also higher exports in terms of value added. The GVC involvement was inferred from the TiVA database, to minimise potential endogeneity between the included series. The sources of the data are summarised in Table A6 in the Appendix. The panel consists of 38 advanced and emerging economies (included in Tables 2 and 3); the time period is rather short as we work with annual data from 1995-2008. The applied econometric method is panel-fixed effects with cluster-robust standard errors. Because of this short time period, the estimation is made for country panels and in growth rates. As a result, we can only identify short-term effects of the exchange rate on export growth.

5.1. Linking exports in gross and value added terms to the REER-TWULC

The first estimations link exports in gross terms to the REER-TWULC in gross and value added terms (Table 4). In line with other recent estimations of gross exports, the sensitivity of gross exports to the real effective exchange rate is rather small even if significant. The differences in the two REERs are not affecting the estimated relation perceptibly. The additional variables are significantly estimated with the expected sign; supply effects and an increasing participation in GVCs are supporting gross

export growth. However, the results change markedly when it comes to explaining value added exports. The sensitivity of exports to the REER is much higher, and the effect of the real exchange rate is more significantly estimated. Of the additional variables, GVC participation seems to systematically improve export performance. The TWULC has thus a higher explanatory power in explaining value added trade than gross trade. As a result, it appears that competitiveness does still impact export performance, but that it is necessary to focus on the domestic component supplied to an exported good.

Table 4: Relation between exports in gross and value added terms and the REER-TWULC

	REER...	C	*t-stat*	DEMAND	*t-stat*	REER	*t-stat*	PROD	*t-stat*	GVC	*t-stat*	R2
X GROSS	**TWULC GROSS**	0.68	*1.6*	0.84	*13.2*	**-0.11**	***-3.7***	0.28	*2.4*	-0.62	*-3.1*	0.36
X GROSS	**TWULC VA**	0.75	*1.8*	0.82	*13.4*	**-0.11**	***-3.9***	0.29	*2.5*	-0.61	*-3.0*	0.36
X VA	**TWULC VA**	2.99	*4.6*	0.69	*8.5*	**-0.46**	***-9.0***	0.08	*0.6*	-0.28	*-1.7*	0.44

Note: For the definitions of the variables, see text. 'PROD' stands for average labour productivity growth, 'GVC' for the participation in global value chains.

The estimations are repeated for four country groups: euro area plus Denmark (excluding not only the countries that were formerly "transition economies" but also Luxembourg, Greece and Malta),[11] developed economies (partly overlapping with the euro area: Austria, Belgium, Germany, Finland, France, Italy, Netherlands; Australia, Canada, Denmark, Japan, Sweden, UK, USA), emerging economies outside the EU (Brazil, China, India, Indonesia, Korea, Mexico, Russia, Turkey), and the ten "new" EU member states. Because the results for the REERs weighted according to gross or VA trade do not differ much, the tables focus on the results for value added exchange rates in all cases.

The earlier results are broadly confirmed in that the sensitivity towards the REER is higher for value added exports than for gross exports and in that the coefficient for the REER is highly significant mainly for value added exports (Table 5). However, the differences between the country groups are substantial. First, gross trade appears to be rather well explained by the estimated equation for the high income and the euro area countries. Explained variation is rather high, and the significance of the REER is higher in these two country groups than for the entire panel. Sensitivity to the REER is above that for the entire panel mainly in the euro area. For the emerging economies and the Eastern EU member states, the quality of the estimated relationship improves markedly when exports are measured in value added terms. Sensitivity towards the REER is highest for the emerging market

[11] Denmark was included here because of its fixed exchange rate towards the euro; Luxembourg, Greece and Malta were excluded because they significantly affected the estimated coefficients for the group and thus clearly violated the homogeneity assumption.

economies. The additional variables are not robust across the specifications. From these tests it emerges that relative price movements still do affect export performance, but that a focus on value added exports is crucial.

Table 5: Relation between exports in gross and value added terms and the REER-TWULC for the country groups

	C		DEMAND		**REER**		PROD		GVC		R2
gross exports national accounts, real											
HIGH INCOME	-0.66	*-1.3*	0.80	*13.4*	**-0.21**	***-5.8***	0.21	*1.2*	-0.34	*-1.7*	0.70
EURO AREA	1.92	*3.8*	0.57	*9.6*	**-0.39**	***-6.5***	0.06	*0.5*	-0.73	*-2.5*	0.72
EMERGING	2.34	*1.6*	0.81	*5.1*	**-0.14**	***-2.1***	0.59	*2.6*			0.29
NMS	2.32	*1.9*	1.04	*6.2*	**-0.08**	***-2.1***			-0.62	*-1.9*	0.26
value added exports WIOD, real											
HIGH INCOME	0.43	*1.0*	0.63	*7.1*	**-0.35**	***-8.8***	0.26	*1.9*			0.65
EURO AREA	2.24	*5.5*	0.37	*6.7*	**-0.48**	***-7.7***	0.26	*2.8*	-0.31	*-2.5*	0.70
EMERGING	3.85	*3.4*	0.88	*5.0*	**-0.60**	***-9.0***			-1.03	*-3.4*	0.52
NMS	3.34	*1.8*	0.93	*3.7*	**-0.36**	***-4.5***					0.36

Note: For the definition of the variables and country groups, see main text. 'PROD' stands for average labour productivity growth, 'GVC' for the participation in global value chains.

5.2. Comparison with other real effective exchange rates

The tests are repeated for the whole set of REERs introduced in section 4.2. and for the entire country sample. As a benchmark, the first line shows the regression of exports on demand only. Exports and demand should be rather close due to the approximation of demand by imports. This is of particular interest in the case of value added exports because in contrast to the gross trade figures from the national accounts, the value added exports and imports are derived from a single source, the WIOD, in which exports and imports match in the world aggregate.

First turning to gross exports, in the basic relation the coefficient of demand is indeed very close to 1; but the explained variation is rather small (first line in Table 6). Explained variation does not increase much when the other tested variables are included. Importantly, the estimated equations for the six alternative REERs do not indicate a substantively different relation between the relative prices and gross exports. Admittedly, sensitivity of gross exports is highest towards the export deflators (i.e. the national accounts based measure related to gross exports), while the REER-TWULC appears to be slightly more significantly estimated. Also, there is a deviation between the estimated sensitivity towards unit labour cost and deflator based REERs, both in the aggregate and in a sectoral specification. However, all indices are significantly related to gross exports and from these results it might be

difficult to identify a clearly dominating indicator among those tested – despite the sometimes strong, but apparently not sufficiently systematic, variation among the REERs.

Table 6: Linking gross exports to the range of real effective exchange rates

REER-...	C	*t-stat*	DEMAND	*t-stat*	**REER**	*t-stat*	PROD	*t-stat*	GVC	*t-stat*	R2
none	1.07	*2.4*	0.96	*15.0*							0.28
sector-specific price and cost measures											
TWULC	0.75	*1.8*	0.82	*13.4*	**-0.11**	***-3.9***	0.29	*2.5*	-0.61	*-3.0*	0.36
TWDEFL	0.59	*1.4*	0.82	*13.3*	**-0.13**	***-2.6***	0.34	*2.9*	-0.63	*-3.0*	0.35
aggregate price and cost measures											
CPI	0.67	*1.6*	0.81	*13.1*	**-0.17**	***-2.6***	0.34	*3.0*	-0.58	*-2.7*	0.37
ULC	0.78	*1.9*	0.81	*13.4*	**-0.13**	***-3.4***	0.32	*2.8*	-0.58	*-2.8*	0.37
DEFL	0.68	*1.6*	0.81	*13.5*	**-0.17**	***-3.0***	0.36	*3.0*	-0.59	*-2.8*	0.37
XGS DEFL	0.64	*1.5*	0.84	*13.8*	**-0.33**	***-3.1***	0.33	*3.2*	-0.67	*-3.3*	0.39

Note: For the definition of the variables and country groups, see main text. 'PROD' stands for average labour productivity growth, 'GVC' for the participation in global value chains.

Table 7: Linking value added exports to the range of real effective exchange rates

REER-...	C	*t-stat*	DEMAND	*t-stat*	**REER**	*t-stat*	PROD	*t-stat*	GVC	*t-stat*	R2
none	2.24	3.5	0.70	6.6							0.11
sector-specific price and cost measures											
TWULC	2.99	*4.6*	0.69	*8.5*	**-0.46**	***-9.0***	0.08	*0.6*	-0.28	*-1.7*	0.44
TWDEFL	2.29	*4.3*	0.69	*9.0*	**-0.60**	***-11.8***	0.28	*2.5*	-0.31	*-1.8*	0.46
aggregate price and cost measures											
CPI	2.52	*4.2*	0.64	*8.7*	**-0.61**	***-12.4***	0.27	*2.3*	-0.22	*-1.3*	0.50
ULC	2.78	*4.2*	0.64	*7.3*	**-0.46**	***-8.6***	0.19	*1.5*	-0.22	*-1.3*	0.44
DEFL	2.41	*4.2*	0.66	*8.1*	**-0.61**	***-12.3***	0.31	*2.8*	-0.24	*-1.4*	0.48
XGS DEFL	1.63	*2.5*	0.70	*7.9*	**-0.47**	***-4.0***	0.24	*1.7*	-0.57	*-2.8*	0.23

Note: For the definition of the variables and country groups, see main text. 'PROD' stands for average labour productivity growth, 'GVC' for the participation in global value chains.

Turning to the estimations for value added exports, the simple relation between deflated value added exports and deflated value added imports by the respective trading partners explains very little (first line in Table 7). The better performance of the value added export relation is hence not the consequence of the fact that the data for exports, demand (imports of trade partners) and trade weights are all derived from the same source. When adding the real effective exchange rates, productivity growth and GVC participation, the quality of the estimated relationship improves substantially. While the effect of productivity and GVC participation does not appear to be very robust across the specifications, all REERs are highly significant. In this case, probably unsurprisingly, the gross trade based export deflators appear to be the least suited to explain value added export performance. Sensitivity towards relative price movements is even bigger for the deflator and the CPI-REER but overall the differences between the REER indicators are not large. Unexpectedly, the REER-CPI (with value added country weights) is no less qualified to monitor external competitiveness than the other REERs. The additional gain from focusing on sectoral trade-weighted indicators seems limited from this estimation for the whole panel. The better performance of value added export equations thus does not hinge on the specific REER measure used but on the export measure.

These results are further supported by estimations for the individual country groups (see Tables A7 and A8 in the Appendix). The marked variation between the country groups found earlier is confirmed, but also the less marked differences within a country group for the individual REERs. For the high income and the euro area countries, all estimated models have a rather good fit and all REERs help explain export performance, in gross and in value added terms. The only exception is the gross export price based REER in relation to value added exports. Also for the emerging markets, the result found for the REER-TWULC applies to most of the other REERs: sensitivity can be low with respect to gross exports but rather high when it comes to exports in value added terms. For the Eastern EU member states, the ULC based REERs are the only competitiveness indicators significantly linked to gross exports; but all REERs except the export price based indicator are significant in the equation for value added exports. Variation between the outcomes for the individual REER is slightly higher for the emerging markets group and the Eastern EU member states, where the variation in REERs is also higher. When comparing the sectoral trade-weighted unit labour costs and deflators across all specifications, the TWULC-REER are more robust.

Overall we confirm the conventional finding that there is no universally dominating price or cost competitiveness measure that beats others for all specifications and all country subsamples. However, our new proposed measure, the TWULC performs relatively well in terms of robustness and should thus be part of the standard set of price and cost competitiveness measures.

5.3. Additional robustness checks

The robustness of the results was checked along several dimensions. With regard to the weighting scheme applied to the real effective exchange rate we used country and sector weights from TiVA instead of WIOD, and time varying weights instead of fixed year 2000 weights. For one price index, we could thus arrive at eight specifications of the REER (gross/VA weights, WIOD/TiVA weights, fixed/time-varying weights). Table 7 summarises the results of these robustness tests for the entire panel of 38 countries, and Table A9 in the Appendix for the four country groups. The most important outcome of this exercise is that variation among the eight regressions for the same price index is most often very low.

Table 8 additionally includes summary statistics for the estimation of value added exports, where external demand is approximated by *gross* imports, i.e. a rather different concept of external demand.

The results are nevertheless very close to those for the value added exports regressed on *value added* demand. Equally, results do not change substantially when gross exports are regressed on value added demand (results not reported here). Although demand of the trade partners generally varies less between the countries than actual exports, that is remarkable. It stresses even more the relevance of the choice of export measure. The rather different results for gross and value added export equations are due mainly to the choice of export measure. What is more, it is not only the expression of exports in value added terms that matters, but also, perhaps even primarily, the specific deflation method. As it was stressed already before, the differences between the two measures of real exports stem to a large extent from the measure of inflation. It is also an important piece of information that variation in the explanatory variables is not systematic enough to yield, in a country panel framework, clearer evidence of the distinct significance and impact of REER measures based on different price indexes or demand measures.

Table 8: Summary statistics on robustness checks

		gross exports, gross imports		**VA exports, VA imports**		**VA exports, gross imports**	
		parameter	*t-stat*	parameter	*t-stat*	parameter	*t-stat*
ALL	mean	-0.18	*-3.0*	-0.53	*-9.4*	-0.52	*-9.5*
	st. dev.	0.08	*0.5*	0.08	*3.0*	0.08	*3.1*
CPI	mean	-0.17	*-2.6*	-0.62	*-12.4*	-0.62	*-12.3*
	st. dev.	0.01	*0.2*	0.01	*0.1*	0.01	*0.2*
ULC	mean	-0.14	*-3.4*	-0.46	*-8.4*	-0.46	*-8.7*
	st. dev.	0.00	*0.2*	0.00	*0.1*	0.00	*0.1*
DEFL	mean	-0.17	*-2.9*	-0.62	*-12.3*	-0.61	*-12.4*
	st. dev.	0.01	*0.2*	0.01	*0.1*	0.01	*0.3*
DEFL-XGS	mean	-0.33	*-3.0*	-0.47	*-4.0*	-0.44	*-3.8*
	st. dev.	0.01	*0.1*	0.01	*0.1*	0.01	*0.2*
TWULC	mean	-0.11	*-3.8*	-0.44	*-8.6*	-0.45	*-8.9*
	st. dev.	0.00	*0.2*	0.02	*0.4*	0.02	*0.4*
TWDEFL	mean	-0.12	*-2.3*	-0.57	*-11.0*	-0.56	*-11.1*
	st. dev.	0.01	*0.3*	0.02	*1.2*	0.03	*1.4*

Notes: The table shows the average of the estimated parameters and t-stats and their standard deviation across the eight specifications mentioned in the text.

6. Conclusions

We tested whether the growing importance of global production chains and the increasing deviation between gross and value added exports necessitates a modification of aggregate measures of an economy's competitiveness. The empirical tests were performed based on an exhaustive dataset for

a panel of 38 countries including indicators for gross and value added exports on the one hand and conventional and value added based REERs on the other.

In addition, we investigated whether a focus on cost and price developments in sectors that actually export improves the explanatory power of relative price measures (real effective exchange rates, REERs) for export performance. Recent empirical investigations have often found a rather low explanatory power of price and cost indicators for the export performance and furthermore have failed to show the dominance of one specific indicator when tested within standard export equations. Two novel measures of price and cost competitiveness were proposed: the trade-weighted unit labour costs (TWULC) and the trade-weighted deflator (TWDEFL). Both give higher weight to sectors that export more and are based on value added trade data. Various real effective exchange rate measures were computed based on our novel indicators and a set of more standard measures.

Overall our results confirm the common finding that the sensitivity of gross exports towards the real effective exchange rate is small and in some specifications even insignificant. However, the explanatory power and, especially, the sensitivity towards relative price measures increases substantially when exports are measured in terms of value added. Their sensitivity towards real effective exchange rates is four times higher than that of gross exports. This effect is even higher for the emerging market economies and the Eastern ("new") EU member states, probably the main targets of outsourcing of individual production stages. Therefore, despite the profound changes in the production processes related to external trade and the increasing importance of cross-border production chains, relative price movements still do affect export performance. However, it is necessary to focus on the domestic component in the traded goods, i.e. value added exports.

At the same time, the sharp focus on exporting industries and on value added weights in real exchange rates yields not only important additional information but also appears to yield more robust results across the several estimated specifications. Our new proposed measure, the TWULC, should thus be part of the standard set of price and cost competitiveness measures. Nevertheless, the newly developed real effective exchange rates cannot systematically beat the more conventional measures of price of cost competitiveness. As a result, some conventional REER measures can be suitable for assessing export competitiveness also when it comes to value added trade. The main result that thus follows from our research is that it is not so much competitiveness measures that are in need of adjustment as figures of external trade performance.

Important research questions arise from our findings with respect to the link between external trade performance and competitiveness. The importance of reliable value added trade data is further underlined. But what is more, we need a clearer idea of the relevant price attached to value added exports. The quite substantial differences between the deflated exports in value added terms and that of gross exports arise not only from the elimination of foreign-sourced intermediates in the former but also, and possibly mainly, from the measures used for deflation. The availability of adequate price data for value added trade is therefore equally urgent as timely and accurate information on value added trade.

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APPENDIX

Table A1: Annual average growth rates of gross and value added exports in current prices and deflated; correlation coefficients between the annual growth rates of gross and value added exports

	1	2	3	4	5	6	7	8	9	10	11
	Gross exports (NA), nominal	Gross exports (WIOD), nominal	VA exports (WIOD), nominal	Gross exports (NA), deflated	VA exports (WIOD), deflated	Gross exports nominal, NA versus WIOD	Gross exports (NA) - Value added exports, nominal	Gross exports (WIOD) - Value added exports, nominal	Gross exports (NA) - Value added exports, deflated	ratio of VA and gross exports (WIOD), 2008	change in ratio since 1995
	average annual growth rate in %					correlation between annual growth rates				in %	in PP
euro area (excluding NMS) plus Denmark											
AUT	8.1	8.5	7.3	7.0	6.4	0.97	0.92	0.97	0.91	65.3	-10.3
BEL	6.1	5.3	4.3	4.6	3.3	0.92	0.87	0.90	0.84	53.1	-7.1
DNK	7.3	7.2	5.6	5.3	3.5	0.98	0.95	0.96	0.94	60.6	-12.9
FIN	7.2	7.1	5.9	7.7	6.4	0.99	0.88	0.90	0.89	65.6	-10.6
FRA	5.4	5.0	4.1	4.9	3.8	1.00	0.96	0.97	0.97	70.5	-8.1
DEU	8.0	7.9	6.7	7.6	6.4	0.99	0.95	0.97	0.95	69.0	-10.3
GRC	10.5	15.0	13.7	6.5	11.0	0.81	0.73	0.97	0.81	69.9	-10.9
IRL	10.7	11.0	10.5	9.7	8.0	0.97	0.93	0.94	0.85	57.7	-3.6
ITA	4.7	5.1	4.3	3.0	2.0	1.00	0.95	0.97	0.97	73.2	-7.0
LUX	11.7	12.0	8.9	8.1	6.0	0.98	0.75	0.78	0.80	38.2	-16.5
MLT	6.3	6.5	7.6	2.4	5.4	0.96	0.83	0.85	0.55	56.2	7.1
NLD	7.4	6.5	5.7	6.0	4.0	0.86	0.90	0.96	0.74	61.7	-5.8
PRT	6.6	6.9	6.2	5.0	4.1	0.98	0.93	0.96	0.93	66.6	-5.6
ESP	8.5	8.9	7.9	6.1	5.0	0.99	0.94	0.94	0.94	69.5	-9.2
developed economies (not euro area)											
AUS	8.5	8.4	8.0	4.3	4.2	0.80	0.81	1.00	0.62	83.5	-3.9
CAN	5.0	4.9	5.2	3.4	3.5	0.98	0.95	0.98	0.81	76.1	2.3
JPN	5.3	5.3	4.2	5.9	6.8	1.00	0.99	0.99	0.90	80.2	-11.7
SWE	6.9	6.9	5.9	6.5	6.2	0.99	0.98	0.98	0.95	65.8	-7.9
GBR	5.6	5.8	5.7	4.8	3.8	0.79	0.75	0.99	0.24	78.1	-0.9
USA	6.5	6.0	5.6	5.1	4.7	0.97	0.94	0.98	0.85	78.0	-4.6
emerging economies (not EU)											
BRA	17.4	17.4	16.9	7.5	6.6	1.00	0.99	1.00	0.11	86.5	-5.3
CHN	18.4	17.2	16.2	17.0	13.3	0.94	0.91	0.98	0.63	75.0	-8.6
IND	19.5	17.9	16.6	13.8	11.0	0.90	0.90	1.00	0.80	77.5	-11.9
IDN	21.3	21.1	20.9	5.7	4.2	1.00	0.99	1.00	0.54	82.8	-1.5
KOR	13.1	12.8	10.4	12.3	9.7	0.99	0.96	0.96	0.48	57.5	-17.9
MEX	15.0	14.9	14.5	5.7	3.7	1.00	0.99	0.99	0.82	70.3	-3.2
RUS	30.2	29.3	29.3	6.5	4.5	0.91	0.91	1.00	-0.03	91.8	0.0
TUR	45.0	46.9	45.6	8.3	11.5	0.98	0.98	0.99	0.42	77.2	-8.9
"new" member states (EU)											
BGR	43.6	42.4	40.3	7.6	3.3	0.98	0.98	1.00	0.41	56.0	-11.6
CZE	9.8	11.4	9.3	9.6	6.4	0.94	0.86	0.94	0.69	53.9	-15.3
EST	17.4	14.2	14.2	10.9	7.7	0.89	0.91	0.93	0.89	62.1	0.1
HUN	17.8	19.2	16.3	12.4	7.8	0.99	0.98	0.96	0.89	51.6	-19.4
LVA	15.2	14.4	13.9	8.4	6.8	0.97	0.88	0.96	0.76	70.8	-4.0
LTU	13.6	13.3	12.3	9.7	7.9	0.96	0.94	0.93	0.71	60.0	-7.0
POL	15.5	15.6	13.7	10.1	8.7	1.00	0.97	0.97	0.76	66.7	-15.9
ROU	39.9	40.4	39.7	10.1	5.8	1.00	0.99	1.00	0.64	71.6	-5.0
SVK	13.2	13.3	11.2	9.8	7.2	0.98	0.88	0.88	0.68	53.0	-14.7
SVN	13.6	12.8	11.8	8.5	6.5	0.97	0.93	0.94	0.87	58.7	-7.3

Source: own computations based on WIOD.

Table A2: Sectors in WIOD and TiVA

Code WIOD	Sectors WIOD	Sectors TiVA	Code TIVA
AtB	Agriculture, Hunting, Forestry and Fishing	Agriculture, hunting, forestry and fishing	AtB
C	Mining and Quarrying	Mining and quarrying	C
15t16	Food, Beverages and Tobacco	Food products, beverages and tobacco	15t16
17t18	Textiles and Textile Products	Textiles, textile products, leather and footwear	17t19
19	Leather, Leather and Footwear		
20	Wood and Products of Wood and Cork	Wood, paper, paper products, printing and publishing	20t22
21t22	Pulp, Paper, Paper , Printing and Publishing		
23	Coke, Refined Petroleum and Nuclear Fuel	Chemicals and non-metallic mineral products	23t26
24	Chemicals and Chemical Products		
25	Rubber and Plastics		
26	Other Non-Metallic Mineral		
27t28	Basic Metals and Fabricated Metal	Basic metals and fabricated metal products	27t28
29	Machinery, Nec not elsewhere classified	Machinery and equipment, nec	29
30t33	Electrical and Optical Equipment	Electrical and optical equipment	30t33
34t35	Transport Equipment	Transport equipment	34t35
36t37	Manufacturing, Nec; Recycling	Manufacturing nec; recycling	36t37
E	Electricity, Gas and Water Supply	Electricity, gas and water supply	E
F	Construction	Construction	F
50	Sale, Maintenance and Repair of Motor Vehicles and Motorcycles; Retail Sale of Fuel	Wholesale and retail trade; Hotels and restaurants	50tH
51	Wholesale Trade and Commission Trade, Except of Motor Vehicles and Motorcycles		
52	Retail Trade, Except of Motor Vehicles and Motorcycles; Repair of Household Goods		
H	Hotels and Restaurants		
60	Inland Transport	Transport and storage, post and telecommunication	60t64
61	Water Transport		
62	Air Transport		
63	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies		
64	Post and Telecommunications		
J	Financial Intermediation	Financial intermediation	J

70	Real Estate Activities	Business services	70t74
71t74	Renting of M&Eq and Other Business Activities		
L	Public Admin and Defence; Compulsory Social Security	Other services	LtP
M	Education		
N	Health and Social Work		
O	Other Community, Social and Personal Services		
P	Private Households with Employed Persons		

Notes: "Nec" stands for "not elsewhere classified". Sector 23 was excluded from the analysis due to its sensitivity to commodity prices; sector P was dropped because of missing data.

Table A3: Sector composition of exports according to gross and VA trade data, Austria and Portugal

	AUSTRIA				PORTUGAL			
	GROSS		VA in trade		GROSS		VA in trade	
	1995	2008	1995	2008	1995	2008	1995	2008
Agriculture, hunting, forestry and fishing	0.9	0.8	2.1	2.0	1.2	1.7	4.9	3.2
Mining and quarrying	0.4	0.7	0.5	0.8	1.0	1.0	1.2	1.3
Food products, beverages and tobacco	2.7	4.4	1.4	2.6	5.1	6.6	2.0	3.0
Textiles, textile products, leather and footwear	5.0	2.0	3.0	1.3	26.0	10.6	15.4	7.4
Wood, paper, paper products, printing and publishing	8.1	6.1	6.1	4.3	8.7	6.6	6.2	5.1
Chemicals and non-metallic mineral products	11.1	10.3	7.8	7.1	8.8	11.1	7.5	7.0
Basic metals and fabricated metal products	9.5	13.0	7.7	8.0	3.1	7.4	3.6	4.7
Machinery and equipment, nec	9.8	11.5	6.2	7.0	3.2	4.7	1.9	3.0
Electrical and optical equipment	9.1	9.1	6.7	6.1	10.3	9.8	5.0	4.9
Transport equipment	9.4	10.9	4.4	5.1	9.8	10.3	3.5	5.0
Manufacturing nec; recycling	2.3	2.4	1.6	1.6	1.7	2.3	1.1	1.6
Electricity, gas and water supply	1.5	1.8	3.0	3.0	0.4	0.6	2.6	2.6
Construction	1.5	1.1	2.1	2.6	0.0	0.1	0.7	1.4
Wholesale and retail trade; Hotels and restaurants	6.1	5.5	13.0	14.5	1.8	4.7	12.3	14.5
Transport and storage, post and telecommunication	9.4	8.7	11.3	9.0	13.1	14.8	13.6	14.5
Financial intermediation	3.1	4.2	6.8	6.8	1.9	1.5	7.0	6.6
Business services	9.1	6.8	13.6	15.5	2.9	4.8	8.5	11.5
Other services	1.1	0.9	2.6	2.6	1.0	1.2	3.0	2.8

Source: WIOD, own calculations.

Table A4: Country composition of exports according to gross and VA trade data, Austria and Portugal

	AUSTRIA				PORTUGAL			
	GROSS		VA in trade		GROSS		VA in trade	
	1995	2008	1995	2008	1995	2008	1995	2008
AUS	0.6	0.7	0.9	1.1	0.6	0.4	0.8	0.7
AUT	0.0	0.0	0.0	0.0	1.4	1.4	1.5	1.3
BEL	3.9	2.1	3.0	1.9	4.6	3.2	3.3	2.3
BRA	0.4	0.8	0.8	1.3	3.1	2.5	3.7	3.1
BGR	0.4	0.7	0.3	0.6	0.0	0.1	0.0	0.1
CAN	0.9	1.3	1.1	1.6	1.2	1.5	1.4	1.6
CHN	0.9	4.3	1.4	5.6	1.1	1.1	1.4	2.2
CZE	3.1	3.7	2.6	2.5	0.1	0.6	0.2	0.5
DNK	1.2	0.7	1.3	0.8	2.3	0.7	2.1	0.7
EST	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.1
FIN	0.8	0.7	0.8	0.7	1.0	0.7	1.0	0.6
FRA	4.2	3.8	5.6	5.1	15.1	12.8	14.6	12.5
DEU	36.5	33.7	29.4	23.3	20.9	12.2	20.1	9.9
GRC	0.5	0.9	0.8	1.2	0.3	0.4	0.5	0.7
HUN	3.1	4.9	2.5	2.9	0.2	0.4	0.2	0.4
IND	0.6	0.5	0.9	1.0	0.1	0.1	0.2	0.5
IDN	1.1	0.3	1.2	0.5	0.0	0.0	0.1	0.2
IRL	0.5	0.6	0.4	0.6	0.7	1.7	0.6	1.2
ITA	9.0	8.6	8.4	8.5	4.4	4.7	4.8	5.5
JPN	1.8	1.2	3.3	2.2	1.4	0.5	2.3	1.3
KOR	0.8	1.1	1.1	1.4	0.2	0.2	0.4	0.5
LVA	0.1	0.2	0.1	0.2	0.0	0.1	0.0	0.1
LTU	0.0	0.1	0.1	0.2	0.0	0.0	0.0	0.1
LUX	0.8	0.3	0.5	0.2	0.1	0.3	0.1	0.2
MLT	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.0
MEX	0.2	0.6	0.4	0.9	0.1	1.0	0.2	1.0
NLD	2.9	1.8	3.0	2.1	3.5	2.8	3.1	2.4
POL	1.2	2.8	1.2	2.7	0.1	1.0	0.2	1.2
PRT	0.4	0.4	0.5	0.6	0.0	0.0	0.0	0.0
ROU	0.9	2.7	0.8	2.7	0.0	0.4	0.1	0.5
RUS	2.0	2.2	2.5	3.2	0.4	1.1	0.7	1.9
SVK	1.3	1.5	1.1	1.1	0.1	0.2	0.1	0.2
SVN	1.5	1.8	1.0	1.2	0.0	0.1	0.1	0.1
ESP	2.9	2.8	3.3	3.8	15.0	29.1	12.9	24.3
SWE	1.6	1.6	1.5	1.5	2.1	1.7	2.1	1.5
TUR	0.5	1.3	0.8	1.9	0.3	1.2	0.4	1.6
GBR	7.5	3.8	8.3	5.4	10.7	8.3	10.3	8.7
USA	5.6	5.8	9.3	9.7	8.9	7.7	10.7	10.5

Source: WIOD, own calculations.

Table A5: Correlation between annual growth rates of several real effective exchange rates with the REER-CPI with gross country weights, 1996-2008

REER…	CPI VA	ULC GROSS	ULC VA	DEFL GROSS	DEFL VA	XGS DEFL GROSS	XGS DEFL VA	TWULC GROSS	TWULC VA	TWDEFL GROSS	TWDEFL VA
	correlation with REER-CPI GROSS										
	euro area (excluding NMS) plus Denmark										
AUT	0.99	0.97	0.98	0.97	0.99	0.93	0.93	0.91	0.95	0.94	0.98
BEL	0.99	0.95	0.95	0.97	0.96	0.93	0.94	0.76	0.91	0.90	0.94
DNK	0.99	0.95	0.95	0.96	0.96	0.82	0.86	0.91	0.93	0.72	0.81
FIN	0.99	0.96	0.96	0.94	0.96	0.78	0.77	0.85	0.92	0.70	0.86
FRA	1.00	0.97	0.98	0.98	0.99	0.94	0.95	0.87	0.96	0.86	0.96
DEU	1.00	0.95	0.96	0.98	0.98	0.93	0.94	0.77	0.91	0.95	0.98
GRC	0.99	0.78	0.83	0.99	0.99	0.93	0.94	0.60	0.78	0.92	0.95
IRL	1.00	0.77	0.79	0.77	0.78	0.57	0.62	0.66	0.68	0.40	0.57
ITA	0.99	0.95	0.95	0.99	0.99	0.95	0.95	0.94	0.96	0.96	0.98
LUX	0.99	0.56	0.61	0.72	0.75	0.04	0.13	0.46	0.51	0.44	0.55
MLT	0.99	0.72	0.73	0.77	0.80	0.21	0.21	0.05	0.17	0.66	0.79
NLD	1.00	0.98	0.98	0.96	0.98	0.79	0.83	0.94	0.96	0.91	0.94
PRT	1.00	0.58	0.72	0.86	0.91	0.73	0.79	0.52	0.78	0.53	0.76
ESP	1.00	0.98	0.98	0.99	0.99	0.86	0.90	0.91	0.97	0.97	0.97
	advanced economies (not EU)										
AUS	0.99	0.95	0.93	0.98	0.96	0.47	0.46	0.91	0.92	0.84	0.87
CAN	1.00	0.96	0.96	0.97	0.97	0.73	0.71	0.73	0.88	0.78	0.82
JPN	1.00	0.99	0.99	1.00	0.99	0.95	0.96	0.91	0.97	0.96	0.98
SWE	1.00	0.88	0.91	0.99	1.00	0.98	0.97	0.58	0.83	0.95	0.98
GBR	0.99	0.98	0.98	0.99	0.98	0.90	0.89	0.95	0.96	0.96	0.98
USA	0.99	0.98	0.98	0.99	0.99	0.95	0.95	0.93	0.96	0.96	0.98
	emerging economies (not EU)										
BRA	1.00	0.98	0.98	0.99	0.99	0.79	0.79	0.97	0.98	0.91	0.95
CHN	1.00	0.98	0.97	0.97	0.96	-0.19	-0.21	0.95	0.96	0.89	0.93
IND	1.00	0.77	0.76	0.95	0.94	0.69	0.69	0.60	0.67	0.85	0.89
IDN	1.00	0.97	0.98	0.98	0.98	0.84	0.85	0.88	0.88	0.92	0.92
KOR	1.00	0.98	0.98	0.99	0.99	0.62	0.63	0.94	0.96	0.98	0.99
MEX	1.00	0.88	0.88	0.95	0.96	0.85	0.86	0.75	0.80	0.93	0.93
RUS	1.00	0.95	0.95	0.95	0.95	0.58	0.59	0.86	0.91	0.82	0.89
TUR	1.00	0.48	0.48	0.92	0.91	0.02	0.02	0.65	0.63	0.82	0.87
	"new" EU member states										
BGR	1.00	0.77	0.76	0.85	0.83	0.64	0.63	0.83	0.81	0.77	0.76
CZE	0.99	0.40	0.42	0.92	0.92	0.75	0.72	0.42	0.44	0.57	0.84
EST	0.98	0.61	0.58	0.89	0.86	0.84	0.83	0.62	0.60	0.68	0.86
HUN	0.98	0.88	0.89	0.91	0.92	0.50	0.60	0.72	0.87	0.69	0.89
LVA	0.99	0.76	0.72	0.89	0.88	0.50	0.43	0.72	0.70	0.78	0.86
LTU	0.99	0.87	0.85	0.98	0.98	0.61	0.62	0.73	0.83	0.96	0.98
POL	1.00	0.73	0.70	0.99	0.98	0.64	0.55	0.85	0.74	0.93	0.96
ROU	1.00	0.82	0.81	0.91	0.89	0.16	0.14	0.81	0.83	0.84	0.89
SVK	0.99	0.82	0.82	0.97	0.94	0.66	0.68	0.48	0.66	0.48	0.91
SVN	0.96	0.91	0.87	0.89	0.88	0.14	0.27	0.77	0.83	0.85	0.86

Source: WIOD, own calculations.

Table A6: Sources of included data

	Trade volumes, country weights measured in … terms	
	GROSS	**VALUE ADDED**
EXPORTS	Real exports of goods and services, national accounts (IMF WEO database)	Deflated value added exports (WIOD database, own deflation)
DEMAND	Weighted real imports of goods and services, national accounts (IMF WEO database)	Weighted deflated value added imports (WIOD database, own deflation)
REAL EFFECTIVE EXCHANGE RATES	CPI (IMF WEO database)	
	GDP DEFLATORS (IMF WEO database)	
	TOTAL ECONOMY UNIT LABOUR COSTS (WIOD database Socio-Economic Accounts)	
	EXPORT DEFLATORS (NAT ACCOUNTS, IMF WEO database)	
	TRADE WEIGHTED UNIT LABOUR COSTS (gross sector weights, WIOD database Socio-Economic Accounts, own calculation)	TRADE WEIGHTED UNIT LABOUR COSTS (value added sector weights, WIOD database Socio-Economic Accounts, own calculation)
	TRADE WEIGHTED DEFLATORS (gross sector weights, WIOD database Socio-Economic Accounts)	TRADE WEIGHTED DEFLATORS (value added sector weights, WIOD database Socio-Economic Accounts)
PRODUCTIVITY	GVA/employment in exporting sectors (WIOD database Socio-Economic Accounts)	GVA/employment in exporting sectors (WIOD database Socio-Economic Accounts)
GVC involvement	VA exports/gross exports (TiVA database)	VA exports/gross exports (TiVA database)

Table A7: Relation between gross exports and value-added real effective exchange rates

REER-...	C		DEMAND		REER		PROD		GVC		R2
high income economies											
none	-1.09	*-2.4*	0.94	*14.4*							0.61
aggregate price and cost measures											
CPI	-0.92	*-2.0*	0.78	*12.8*	**-0.20**	***-4.3***	0.34	*2.1*	-0.35	*-1.7*	0.69
ULC	-0.84	*-1.7*	0.79	*13.4*	**-0.20**	***-4.7***	0.29	*1.8*	-0.35	*-1.7*	0.69
DEFL	-0.92	*-2.0*	0.78	*13.6*	**-0.20**	***-5.1***	0.32	*2.0*	-0.37	*-1.8*	0.70
D-XGS	-0.89	*-2.0*	0.80	*15.2*	**-0.29**	***-5.2***	0.28	*1.9*	-0.38	*-1.8*	0.69
sector-specific price and cost measures											
TWULC	-0.66	*-1.3*	0.80	*13.4*	**-0.21**	***-5.8***	0.21	*1.2*	-0.34	*-1.7*	0.70
TWDEFL	-0.98	*-2.4*	0.80	*15.0*	**-0.19**	***-6.7***	0.31	*2.0*	-0.39	*-1.8*	0.68
euro area											
none	-0.38	*-0.8*	0.97	*13.5*							0.55
aggregate price and cost measures											
CPI	1.50	*3.4*	0.52	*6.4*	**-0.41**	***-5.2***	0.35	*2.8*	-0.75	*-2.5*	0.71
ULC	1.92	*4.0*	0.54	*9.3*	**-0.41**	***-6.9***	0.20	*2.0*	-0.64	*-2.2*	0.72
DEFL	0.99	*2.0*	0.59	*8.2*	**-0.33**	***-5.0***	0.35	*2.8*	-0.87	*-2.4*	0.69
D-XGS	0.72	*1.5*	0.61	*7.6*	**-0.39**	***-3.3***	0.37	*2.6*	-0.90	*-2.6*	0.69
sector-specific price and cost measures											
TWULC	1.92	*3.8*	0.57	*9.6*	**-0.39**	***-6.5***	0.06	*0.5*	-0.73	*-2.5*	0.72
TWDEFL	0.48	*0.9*	0.66	*8.1*	**-0.21**	***-2.5***	0.34	*2.7*	-0.94	*-2.6*	0.66
emerging economies											
none	4.32	*5.5*	0.78	*6.9*							0.14
aggregate price and cost measures											
CPI	2.06	*1.3*	0.83	*4.5*	**-0.23**	***-2.2***	0.66	*2.9*			0.37
ULC	2.35	*1.7*	0.79	*5.0*	**-0.18**	***-2.1***	0.61	*2.6*			0.32
DEFL	2.10	*1.4*	0.81	*4.8*	**-0.22**	***-2.1***	0.68	*2.8*			0.34
D-XGS	2.04	*1.6*	0.94	*4.6*	**-0.45**	***-2.5***	0.54	*2.9*			0.43
sector-specific price and cost measures											
TWULC	2.34	*1.6*	0.81	*5.1*	**-0.14**	***-2.1***	0.59	*2.6*			0.29
TWDEFL	2.36	*1.6*	0.79	*5.0*	**-0.16**	***-1.6***	0.64	*2.4*			0.29
"new" EU member states											
none	2.11	*1.7*	1.10	*6.0*							0.23
aggregate price and cost measures											
CPI	2.09	*1.6*	1.05	*6.1*	**-0.06**	***-0.8***			-0.64	*-1.9*	0.26
ULC	2.39	*1.9*	1.04	*6.2*	**-0.08**	***-2.2***			-0.61	*-1.9*	0.27
DEFL	2.43	*2.1*	1.04	*6.4*	**-0.11**	***-1.6***			-0.62	*-1.9*	0.26
D-XGS	2.05	*1.5*	1.07	*6.2*	**-0.12**	***-1.0***			-0.65	*-2.0*	0.26
sector-specific price and cost measures											
TWULC	2.32	*1.9*	1.04	*6.2*	**-0.08**	***-2.1***			-0.62	*-1.9*	0.26
TWDEFL	2.27	*1.8*	1.04	*6.3*	**-0.08**	***-1.0***			-0.64	*-1.9*	0.26

Table A8: Relation between value added exports and value-added real effective exchange rates

REER-...	C		DEMAND		REER		PROD		GVC		R2
high income economies											
none	-0.13	-0.34	0.80	12.92							0.43
aggregate price and cost measures											
CPI	-0.11	*-0.3*	0.61	*7.2*	**-0.38**	***-12.3***	0.46	*3.0*			0.65
ULC	0.08	*0.2*	0.63	*7.2*	**-0.35**	***-11.1***	0.38	*2.6*			0.65
DEFL	-0.11	*-0.3*	0.63	*7.6*	**-0.38**	***-9.1***	0.43	*2.9*			0.65
D-XGS	-0.35	*-0.8*	0.69	*6.4*	**-0.35**	***-2.7***	0.40	*2.9*			0.57
sector-specific price and cost measures											
TWULC	0.43	*1.0*	0.63	*7.1*	**-0.35**	***-8.8***	0.26	*1.9*			0.65
TWDEFL	-0.19	*-0.6*	0.66	*7.6*	**-0.36**	***-7.1***	0.40	*2.7*			0.63
euro area											
none	-0.11	*-0.3*	0.85	*14.2*							0.42
aggregate price and cost measures											
CPI	1.66	*4.3*	0.32	*4.7*	**-0.52**	***-6.9***	0.59	*4.3*	-0.33	*-2.3*	0.70
ULC	2.09	*4.9*	0.34	*6.2*	**-0.50**	***-7.0***	0.42	*5.0*	-0.21	*-1.5*	0.70
DEFL	1.44	*3.3*	0.35	*4.9*	**-0.51**	***-6.1***	0.60	*4.1*	-0.45	*-2.6*	0.70
D-XGS	0.79	*2.0*	0.41	*5.2*	**-0.47**	***-4.9***	0.66	*4.4*	-0.53	*-2.8*	0.65
sector-specific price and cost measures											
TWULC	2.24	*5.5*	0.37	*6.7*	**-0.48**	***-7.7***	0.26	*2.8*	-0.31	*-2.5*	0.70
TWDEFL	1.15	*2.3*	0.39	*3.9*	**-0.43**	***-4.6***	0.60	*4.2*	-0.56	*-2.8*	0.66
emerging economies											
none	7.08	*3.9*	0.24	*0.8*							0.01
aggregate price and cost measures											
CPI	4.61	*3.7*	0.71	*3.7*	**-0.68**	***-13.8***			-0.94	*-2.1*	0.61
ULC	4.78	*3.8*	0.67	*3.4*	**-0.58**	***-8.2***			-0.90	*-3.0*	0.51
DEFL	4.51	*3.9*	0.77	*4.6*	**-0.68**	***-14.1***			-0.86	*-2.7*	0.58
D-XGS	3.41	*2.5*	0.64	*2.8*	**-0.60**	***-4.1***			-2.30	*-2.6*	0.22
sector-specific price and cost measures											
TWULC	3.85	*3.4*	0.88	*5.0*	**-0.60**	***-9.0***			-1.03	*-3.4*	0.52
TWDEFL	4.16	*4.2*	0.93	*7.1*	**-0.70**	***-12.9***			-0.84	*-3.4*	0.57
"new" EU member states											
none	1.07	*0.9*	1.00	*4.8*							0.16
aggregate price and cost measures											
CPI	4.11	*2.1*	0.93	*4.4*	**-0.62**	***-3.6***					0.42
ULC	3.30	*1.8*	0.93	*3.7*	**-0.35**	***-4.6***					0.36
DEFL	4.44	*2.1*	0.90	*3.5*	**-0.61**	***-4.0***					0.37
D-XGS	1.90	*1.1*	1.04	*6.1*	**-0.38**	***-1.2***					0.19
sector-specific price and cost measures											
TWULC	3.34	*1.8*	0.93	*3.7*	**-0.36**	***-4.5***					0.36
TWDEFL	4.43	*2.3*	0.88	*3.6*	**-0.61**	***-5.0***					0.37

Table A9: Robustness checks for the tests within country groups

high income countries		gross exports, gross imports		VA exports, VA imports	
		parameter	*t-stat*	parameter	*t-stat*
ALL	mean	-0.21	*-5.7*	-0.36	*-7.8*
	st. dev.	0.04	*1.2*	0.02	*3.0*
CPI	mean	-0.20	*-4.5*	-0.39	*-11.2*
	st. dev.	0.00	*0.3*	0.01	*0.9*
ULC	mean	-0.20	*-5.1*	-0.36	*-10.5*
	st. dev.	0.00	*0.4*	0.01	*0.7*
DEFL	mean	-0.20	*-5.5*	-0.38	*-8.7*
	st. dev.	0.00	*0.4*	0.01	*0.5*
DEFL-XGS	mean	-0.30	*-5.0*	-0.36	*-2.5*
	st. dev.	0.01	*0.2*	0.01	*0.1*
TWULC	mean	-0.21	*-6.6*	-0.35	*-7.6*
	st. dev.	0.01	*0.5*	0.01	*0.8*
TWDEFL	mean	-0.18	*-7.8*	-0.35	*-6.3*
	st. dev.	0.01	*0.8*	0.01	*0.8*

euro area countries (not NMS)		gross exports, gross imports		VA exports, VA imports	
		parameter	*t-stat*	parameter	*t-stat*
ALL	mean	-0.37	*-5.0*	-0.50	*-6.0*
	st. dev.	0.09	*1.9*	0.06	*1.4*
CPI	mean	-0.44	*-5.4*	-0.57	*-6.8*
	st. dev.	0.03	*0.3*	0.04	*0.3*
ULC	mean	-0.43	*-7.0*	-0.52	*-6.8*
	st. dev.	0.02	*0.3*	0.02	*0.4*
DEFL	mean	-0.34	*-5.1*	-0.54	*-5.9*
	st. dev.	0.02	*0.3*	0.03	*0.4*
DEFL-XGS	mean	-0.41	*-3.1*	-0.50	*-4.5*
	st. dev.	0.02	*0.1*	0.02	*0.3*
TWULC	mean	-0.38	*-7.0*	-0.47	*-7.7*
	st. dev.	0.01	*0.8*	0.02	*0.6*
TWDEFL	mean	-0.18	*-2.2*	-0.41	*-4.1*
	st. dev.	0.04	*0.5*	0.03	*0.6*

emerging economies (not EU)		gross exports,		VA exports,	
		parameter	*t-stat*	parameter	*t-stat*
ALL	mean	-0.23	*-2.0*	-0.63	*-9.6*
	st. dev.	0.11	*0.3*	0.05	*3.7*
CPI	mean	-0.23	*-2.1*	-0.68	*-14.0*
	st. dev.	0.00	*0.0*	0.00	*0.5*
ULC	mean	-0.18	*-2.0*	-0.58	*-7.7*
	st. dev.	0.00	*0.0*	0.00	*0.2*
DEFL	mean	-0.22	*-2.0*	-0.69	*-13.6*
	st. dev.	0.00	*0.0*	0.00	*0.8*
DEFL-XGS	mean	-0.47	*-2.5*	-0.62	*-4.1*
	st. dev.	0.01	*0.0*	0.01	*0.2*
TWULC	mean	-0.14	*-1.9*	-0.57	*-7.9*
	st. dev.	0.01	*0.1*	0.03	*1.0*
TWDEFL	mean	-0.15	*-1.4*	-0.66	*-10.4*
	st. dev.	0.01	*0.1*	0.04	*2.3*

"new " EU member states		gross exports,		VA exports,	
		parameter	*t-stat*	parameter	*t-stat*
ALL	mean	-0.09	*-1.5*	-0.48	*-3.5*
	st. dev.	0.03	*0.7*	0.12	*1.2*
CPI	mean	-0.06	*-0.9*	-0.61	*-3.3*
	st. dev.	0.02	*0.5*	0.01	*0.0*
ULC	mean	-0.08	*-2.1*	-0.34	*-4.1*
	st. dev.	0.01	*0.5*	0.00	*0.1*
DEFL	mean	-0.12	*-1.7*	-0.60	*-3.6*
	st. dev.	0.02	*0.7*	0.01	*0.1*
DEFL-XGS	mean	-0.14	*-1.1*	-0.39	*-1.2*
	st. dev.	0.03	*0.3*	0.03	*0.0*
TWULC	mean	-0.09	*-2.3*	-0.35	*-4.0*
	st. dev.	0.01	*0.4*	0.01	*0.1*
TWDEFL	mean	-0.09	*-1.1*	-0.59	*-4.7*
	st. dev.	0.02	*0.4*	0.02	*0.6*

Competitiveness Research Network
This paper presents research conducted within the Competitiveness Research Network (CompNet). The network is composed of economists from the European System of Central Banks (ESCB) - i.e. the 29 national central banks of the European Union (EU) and the European Central Bank – a number of international organisations (World Bank, OECD, EU Commission) universities and think-tanks, as well as a number of non-European Central Banks (Argentina and Peru) and organisations (US International Trade Commission). The objective of CompNet is to develop a more consistent analytical framework for assessing competitiveness, one which allows for a better correspondence between determinants and outcomes. The research is carried out in three workstreams: 1) Aggregate Measures of Competitiveness; 2) Firm Level; 3) Global Value Chains CompNet is chaired by Filippo di Mauro (ECB). Workstream 1 is headed by Pavlos Karadeloglou (ECB) and Konstantins Benkovskis (Bank of Latvia); workstream 2 by Antoine Berthou (Banque de France) and Paloma Lopez-Garcia (ECB); workstream 3 by João Amador (Banco de Portugal) and Frauke Skudelny (ECB). Monika Herb (ECB) is responsible for the CompNet Secretariat. The refereeing process of CompNet papers is coordinated by a team composed of Filippo di Mauro (ECB), Konstantins Benkovskis (Bank of Latvia), João Amador (Banco de Portugal), Vincent Vicard (Banque de France) and Martina Lawless (Central Bank of Ireland). The paper is released in order to make the research of CompNet generally available, in preliminary form, to encourage comments and suggestions prior to final publication. The views expressed in the paper are the ones of the author(s) and do not necessarily reflect those of the ECB, the ESCB, and of other organisations associated with the Network.

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